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March 5.

Monday

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F R.









*McLutton*

# Philosophical Account

OF THE

# WORKS OF NATURE:

As Founded upon

A PLAN of the late Mr. ADDISON.

CONTAINING,

- |  |   |
|--|---|
| <p>I. The several Gradations remarkable in the Mineral, Vegetable, and Animal Parts of the Creation; tending to the Composition of a Scale of Life.</p> <p>II. A Representation of the present State of Gardening throughout <i>Europe</i> in general, and <i>Great Britain</i> in particular.</p> | <p>III. New Experiments relating to the Improvement of Barren Grounds, Timber-Trees, Fruit-Trees, Vines, Sallads, Pulse, and all Kinds of Grain.</p> <p>IV. Observations on the Husbandry of <i>Flanders</i>, in sowing Flax, whereby Land may be advanced <i>Cent. per Cent.</i></p> |
|--|---|

By **RICHARD BRADLEY, F.R.S.**  
 Professor of Botany in the University of Cambridge.

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— All their known Virtue appears  
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 Of Creatures animate with gradual Life.  
 Of Growth, Sense, Reason —

MILTON.

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To the Right Honourable

C H A R L E S,

E A R L of O R R E R Y,

*Knight of the Most Antient Order  
of the T H I S T L E, &c.*

My L O R D,



O U R Lordship's Appro-  
bation of the following  
Work, is sufficient to gain  
it a favourable Reception  
with the Learned World :  
For as that Part of Mankind is unani-  
mous in Opinion of Your Lordship's  
Accurate Judgment in all Kinds of  
Learning ; so whatever appears under  
*Your* Patronage, must necessarily en-  
gage an universal Esteem.



## DEDICATION.

And this, My Lord, is the Happiness I reap from those Labours which I design for general Use, to see them supported by so Noble and Learned a Patron; and to have the Honour of declaring to the World in this publick Manner, that I am, with the greatest Respect,

*My LORD,*

*Your Lordship's*

*Most Devoted, and*

*Most Humble Servant,*

RICHARD BRADLEY.





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# INTRODUCTION.



THE Great Mr. *Addison*, (whose Memory will ever be revered by the Learned and Curious Part of Mankind, for the excellent Lessons he has given the World) among other instructive Pieces, has so beautifully represented some of the Remarkables in Nature's Works, that it is reasonable to believe a Continuance of his Life would have furnished us with such a *Natural History*, as would have been useful to Men of all Kinds of Learning.

This Learned Gentleman, in the *Spectator*, N<sup>o</sup> 121, gives us his Opinion concerning Natural History, in the following Words:

“ I could wish our *Royal Society* would  
“ compile a Body of Natural History, the best  
“ that could be gather'd together from Books  
“ and Observations. If the several Writers a-  
“ mong them took each his particular Species,  
“ and gave us a distinct Account of its Original,  
“ Birth, and Education; its Policies, Hostili-

B

“ ties,



## INTRODUCTION.

“ ties, and Alliances, with the Frame and  
“ Texture of its inward and outward Parts;  
“ and particularly those which distinguish it  
“ from all other Animals; with their peculiar  
“ Aptitudes for the State of Being, in which  
“ Providence has placed them; it would be  
“ one of the best Services their Studies could  
“ do Mankind, and not a little redound to the  
“ Glory of the All-wise Contriver.

I am proud to own in this Place, that it was Mr. *Addison* who first gave me this curious Thought, and led me to the Composition of the following Treatise, which, however I have been fortunate in putting together, I can venture to affirm it consists of Truth so far as I have mention'd any Thing upon my own Knowledge. But as the World, in Cases of this Nature, is commonly jealous of the Facts related, I have here given my Reader an Opportunity of surveying the several Curiosities I have mention'd, by directing him to those Cabinets where each respective Subject is lodg'd.

It is not to be expected, that, in so small a Work, I can give a full Relation of the Exterior and Interior Parts of Bodies; nor can it be supposed that even It could contain the Names of every different *Mineral Plant*, or *Animal* that is commonly known; for it is true, (as Mr. *Addison* observes in the above-mention'd Paper) “ That a Natural History, after all the  
“ Disquisitions of the Learned, would be infinitely short and defective. Seas and Desarts hide  
“ Mil-



## INTRODUCTION.

“ Millions of *Animals* from our Observation ; in-  
“ numerable Artifices and Stratagems are acted  
“ in the *howling Wilderness*, and in the *great*  
“ *Deep*, that can never come to our Knowledge.  
“ Besides that, there are infinitely more Spe-  
“ cies of Creatures, which are not to be  
“ seen without, nor indeed with the Help  
“ of the finest Glasses, than of such as are  
“ bulky enough for the naked Eye to take  
“ hold of. However, from the Consideration  
“ of such *Animals* as lie within the Compass  
“ of our Knowledge, we might easily form a  
“ Conclusion of the rest, that the same Variety  
“ of Wisdom and Goodness runs through the  
“ whole Creation, and puts every Creature in  
“ a Condition to provide for its Safety and  
“ Subsistence in its proper Station.”

From this useful Plan for *Natural History*,  
I have endeavoured to lay the Foundation of  
my Building, and shall account myself happy  
enough, if among the Parts I have touched  
upon I have hit on any Thing new and useful,  
which may contribute to advance so benefi-  
cial an Undertaking.

LONDON,  
1721.

R. B.









A

PHILOSOPHICAL ACCOUNT  
OF THE  
WORKS of NATURE.

---

CHAP. I.

*Of the most remarkable Appearances in* EARTHS  
and MINERAL BODIES.



PROPOSE, *first*, to treat of *Earths* and *Mineral* Bodies, supposing them to subsist much longer without any considerable Alteration of Parts, than any other of the created Bodies. *Vegetables, Animals, and Insects* have respectively their Modes of Growth very different from one another, each of them undergoing visible Alterations till they are perfect; but *Earths* and *Mineral* Bodies require Length of Time to perfect themselves in their respective Stations: Which Time of their Tendency to Perfection I shall, for the Ease of



6      *A Philosophical Account of the*  
some of my Readers, call the Time of their  
Growth.

What I here call *Earth*, is whatever Soil I find in the superficial and second *Strata*, such as may be used for the Propagation of Vegetables; perhaps in some Cases we may even use the third *Stratum* for the Profit of Plants; but all the *Strata* below this I shall suppose are so many Beds of Mineral Matter, either in a State of Solution, or Consolidation, or else hardened as much as ever they will be.

It would be tedious to enumerate every Particular which might be observed in all the *Earths* that are used for the Production of *Vegetables*; there are undoubtedly many thousand different Mixtures, which have either been made designedly, or have happened by Accident. It will suffice for my present Purpose to distinguish them under *three* General Heads, as *Sand*, *Loam*, and *Clay*; for all *Earths* are in some Degree or other partaking of these; and it is my Opinion that they all originally were made up of *Sandy-Particles*, but varied only in their Powers, by mixing with Liquids of different Qualities, (*i. e.*) such as are *Aqueous*, *Viscous*, and *Oleaginous*.

The Particles of *Sand* which compose *Earth* are not all of the same Dimensions; some are big enough to be observed distinctly by the naked Eye, while others are scarcely to be discerned with the Microscope; yet every one of these Parts, however small it is, may (I suppose)



pose) lose of it Bulk and Weight, or add to both, by being exposed to different Degrees of Heat; and so consequently when many of them are united, that united Body will still maintain so much of the natural Disposition of the Parts it was composed of, that a certain Degree of Heat would have the same Effect upon it, that it would proportionably have upon the least Particle of its Composition; for even a *Diamond*, which is the hardest *Gem* known in the World, will lose a Share of its Weight by means of a powerful *Burning-Glass*; an Instance of which we find in *Phil. Transactions*, N<sup>o</sup> 360, where, in the Account of Experiments made with Mr. *Villette's* Burning-Concave in June 1718, by the Reverend Dr. *Harris* and Dr. *Desaguliers*, we find that a *Diamond* weighing 4 Grains, lost 7 Eighths of its Weight, an *Emerald* was melted into a Substance like a *Turkey-Stone*, the *Asbestos* seemed condensed a little in 28 Seconds, but it was then something cloudy: Mr. *Villette* says that the Glass usually calcines it. A *Copper* Halfpenny melted in 20 Seconds, a Sixpence in 7 Seconds and  $\frac{1}{2}$ ; Tin melted in 3 Seconds; Cast-Iron, in 16 Seconds; Slate, in 3 Seconds; Tile, in 4 Seconds, and vitrified thorough in 80; Bone calcined in 4 Seconds, and vitrified thorough in 33; *Calculus-Humanus* calcined in 2 Seconds; Talk began to calcine in 40 Seconds, and a Fossile-Shell in 7 Seconds; Chalk fled away in 23 Seconds.

N. B. *Mr. Villette's Mirour is a Concave of 47 Inches wide, and ground to a Sphere of 76 Inches Radius, so that its Focus is about 38 Inches distant from the Vertex of the Glafs.*

From whence it appears, that every Mineral or other Body, as it is more or less consolidated or hardened, is more or less subject to the Impressions made by Heat or Cold; and this I mention the rather, because I would offer a *Query*, whether if these Parts of *Sand, &c.* being subject to dilate or contract, may not by means of their *Pores* receive a kind of nourishing or improving Juice from the next neighbouring *Liquid*, and by that Help in a long Series of Years swell and become larger than we might suppose them at first. If this were allowed, we might then suppose *Mineral Bodies* had a kind of Growth, and even hope to discover the Mode of Generation of *Minerals* or *Stones*; which Work, I am informed, the celebrated *Malpighius* had began.

But further; divide 3 Pounds of *Sand* into 3 Parcels, well dried, and make each Parcel into a Paste, the *first* with common Water, the *second* with some viscous Matter, such as a Solution of *Soap* and Water, or a kind of *Liquid-Soap*, and the *third* with *Oil*, and lay them for some Time exposed to the Sun; the *Sand* and *Water*, as it dries, will fall to Pieces, or separate with a small Breath of Air; the  
*Soap*



*Soap* and *Sand* will be more retentive, and will not separate without some Difficulty; and the *Oil* and *Sand* will be baked so hard, as to require a considerable Force to divide its Parts from one another.

I suppose then that the 3 several Soils I have mentioned, *viz.* *Sand*, *Loam*, and *Clay*, are all of them composed of *Sandy* Particles, but differently mix'd with Liquids analogous to those I have mentioned, and by that means are more or less binding.

All Kinds of *Sandy-Soil* are nourished with *watery* Parts.

*Loam* mix'd with some *viscous* Liquid, and therefore more binding than *Sand*.

*Clay* mix'd with *Oily* Parts, and therefore more binding than *Loam*.

And I the rather believe this, because *Water* easily penetrates the *Loam*, and the viscous Parts in it may be washed away without Difficulty; but *Clay* is more stubborn, and resists the *Water*; which seems to demonstrate that the Parts it is composed of, are bound together by somewhat oleaginous.

*Chalk* I take to be a certain Degree of *Clay*, whose Parts are more ripened; and *Marle* to be some undigested Matter, which Length of Years would ripen and consolidate.

I observe that neither *Earths* or *Minerals* are always constant, with regard to the Depth and Situation of their *Strata*, as we may see in several Relations sent to the *Royal Society* by

by some of their ingenious and learned Members. In *Phil. Trans.* N<sup>o</sup> 336, Mr. *Fettyplace Bellers* gives us the following Account of the *Strata* of *Earth, Stone, &c.* found in a *Coal-Pit* at the West End of *Dudley* in *Staffordshire*.

The 1<sup>st</sup> *Stratum* immediately under the *Turf*, a Yellowish-Clay, 4 Feet thick.

2<sup>d</sup>, A Blueish-Clay, 5 Feet thick.

3<sup>d</sup>, A Blueish hard Clay, called *Chinch* by Miners; it is one of the certain Signs of Coal. This *Stratum* is 24 Feet thick.

4<sup>th</sup>, A Blueish soft Clay, 9 Feet thick.

5<sup>th</sup>, A fine-grained Grey-Stone, which is found in some Pits only, 4 Feet.

6<sup>th</sup>, A Clay almost like the first, but whiter, 21 Feet.

7<sup>th</sup>, A hard Grey Rock, 75 Feet.

8<sup>th</sup>, A Blue *Chinch*, like N<sup>o</sup> 3, 5 Feet.

9<sup>th</sup>, A Black Substance, called the *Dun Row Batt*, 1 Foot.

10<sup>th</sup>, Coal, called *Bench-Coal*, 3 Feet.

11<sup>th</sup>, Coal, called *Slipper-Coal*, less black and shining than the former, 3 Feet.

12<sup>th</sup>, Coal, called *Spin-Coal*, more black and shining, 4 Feet.

13<sup>th</sup>, A Coal, by the Miners called *Stone-Coal*, like *Canal-Coal*, 4 Feet.

N. B. These *Strata* of Coal, have, between each of them, a Batt as thick as a Crown-Piece.

14<sup>th</sup>, A Black Substance, called *Dun Row Batt*, the same with N<sup>o</sup> 9, one Foot.

15<sup>th</sup>,



15th, A hard Grey Iron-Ore, called *Dun Row Iron Stone*, 1 Inch thick.

16th, A Blueish Batt, (in which lies the following Iron Stone) called the *White Row*, 3 Inches.

17th, A hard Blackish Iron-Ore, lying in small Nodules, having between them a *white* Substance, and therefore called by the Miners, *White Row Grains*, or *Iron Stone*, 1 Foot 3 Inches.

18th, A hard Grey Iron-Ore, with some *White Spots* in it, called the *Midrow Grains*, 2 Inches.

19th, A Black fissile Substance, called *Gublin Batt*, 2 Foot.

20th, A hard *Blackish* Iron-Ore, with *White Spots* in it, called the *Gublin Iron Stone*, 9 Inches,

21st, A *Batt*, in Substance much like that in N<sup>o</sup> 19, one Foot 6 Inches.

22d, A hard Grey *Iron-Ore*, called *Cannoc*, or *annoc Iron Stone*, 6 Inches.

23d, A *Batt* somewhat harder than N<sup>o</sup> 21, one Foot.

24th, A dark Grey hard *Iron-Ore*, called *Rubble Iron Stone*, 6 Inches.

25th, The *Table-Batt*, next under the *Rubble Iron-Stone*, 2 Feet.

26th, A coarse *Coal*, called *Foot-Coal*, 1 Foot.

27th, A Black brittle shining *Batt*, 6 Feet.

28th, The *Heathenoal*, 6 Feet.

29th,

29<sup>th</sup>, A Substance like Coarse Coal, by the Miners call'd a *Batt*, 1 Inch.

30<sup>th</sup>, The Bench-Coal, 2 Feet.

31<sup>st</sup>, A *Batt*, 6 Inches thick.

This is as low as they generally dig, tho' there is a *Coarse Coal* under this. We are to remark, that those Substances which divide the *Strata* of Coals and Iron-Ores, are called *Batts* by the Miners; they are generally black, consisting of a Matter peculiar to themselves, and are of a Texture nearest like *Marle*, tho' some of them are fissile, and others have a Substance not unlike *Coal*, mix'd with them. It appears from hence that this *Coal-Mine* is 188 Feet  $\frac{1}{2}$  deep.

The other Account is of the *Strata* observed in the *Coal-Mines* of *Mendip* in *Somersetshire*, and communicated to the *Royal Society* by Dr. *Welsted*, in a Letter to him from *John Strachey*, Esq; and inserted in *Phil. Trans.* N<sup>o</sup> 360, in which we may observe that the Situation of the *Strata* are very different from those in the *Coal-Mine* at *Dudley* above-mentioned. “ We find in the digging for *Coal* “ about *Mendip*, says our *Author*, the Surface “ is mostly a red Soil, which under the first “ or second Spit, degenerates into *Malm* or “ *Loam*, and often yields a Rock of reddish “ *Firestone*, till you come to 4, 5, or many “ Times 12 or 14 Fathom deep, when by “ Degrees it changeth to a grey, then to a dark

“ or



“ or *blackish* Rock, which they call the *Coal-*  
 “ *Clives*; these always lie shelving and regular  
 “ as the *Coal* doth: But in these Parts they  
 “ never meet with *Firestone* over the *Coal*, as  
 “ at *Newcastle* and in *Staffordshire*; these *Clives*  
 “ vary much in Hardness, in some Places be-  
 “ ing little harder than *Malm* or *Loam*, in o-  
 “ thers so hard, that they are forced to split  
 “ them with Gunpowder; so likewise in Co-  
 “ lour, the Top inclining to *red* or *grey*, but  
 “ the nearer to *Coal* the blacker they grow;  
 “ and where-ever they meet with them, they  
 “ are sure to find *Coal* under them. The first  
 “ or uppermost *Coal-Vein* at *Sutton* is called  
 “ the *Stinking Vein*; it is hard *Coal* for Me-  
 “ chanic Uses, but of a sulphureous Smell. A-  
 “ bout 5 Fathom and  $\frac{1}{2}$  (seldom more than 7  
 “ Fathom) under this, lies another Vein, which  
 “ (from certain Lumps of Stone mixed with it,  
 “ like a *Caput Mortuum* not inflamaeble) called  
 “ *Cat's-head*, they call the *Cat-head Vein*. A-  
 “ bout the same Depth again under this lies  
 “ the *Three-Coal-Vein*, so called because it is  
 “ divided into *three* different *Coals*: Between  
 “ the *first* and *second* Coal, is a Stone of a  
 “ Foot, in some Places 2 Feet thick; but the  
 “ middle and *third* Coal seemed placed loose  
 “ on each other, without any Separation of  
 “ different Matter.

“ Next under the *Three-Coal-Veins*, is the  
 “ *Peaw-Vein*, so called, because the *Coal* is  
 “ figured with *Eyes* resembling a *Peacock's*  
 “ Tail,

“ Tail, gilt with Gold, which Bird in this  
 “ Country is called a *Peaw*. The Cliff over  
 “ this Vein is variegated with *Cockle-Shells*  
 “ and *Fern-Branches*, and is always an Indi-  
 “ cation of this Vein; and under this again  
 “ between 5 and 6 Fathom lies the *Smith's-*  
 “ *Coal-Vein*, about a Yard thick, and near the  
 “ same Depth; under that the *Shelly-Vein*;  
 “ and below that a Vein of 10 Inches thick,  
 “ which being little valued, has not been  
 “ wrought to any Purpose. Some say there  
 “ is also another under the last, but that has  
 “ not been proved within Man's Memory.  
 “ At *Faringdon*, which lies 4 Miles distant  
 “ from the Mines of *Sutton*, the *Strata* agree  
 “ in all Parts.

“ Between *Faringdon* and *High-Littleton*  
 “ the same Veins seem to retain their regular  
 “ Course; but at *Littleton* their lowest Vein is  
 “ the best *o al*, which at *Faringdon* proves  
 “ small.

“ The same Veins are found again in the  
 “ Parish of *Stanton-Drew*, a Mile distant from  
 “ *Sutton*, only at *Stanton* they have little of  
 “ the *Red-Earth*, or *Malm*, on the Surface,  
 “ but come immediately to an *Iron Grit*, or  
 “ *grey Tile-stone*, which is a Fore-runner of  
 “ the *Coal Clives*.

“ Now as *Coal* is here generally dug in the  
 “ Valleys, so the Hills seem also to observe a  
 “ regular Course in the *Strata* of *Stone* and  
 “ *Earth* found in their Bowels; for in these  
 “ Hills



“ Hills (I mean those that are dispers’d between  
“ the Coal Works above-mentioned) we find  
“ on the Summits a *Stony Arable* mixed with  
“ a spongy yellowish Clay ; under which are  
“ Quarries of *Lyas*, in several Beds, to about  
“ 8 or 10 Feet deep ; and 6 Feet under that,  
“ thro’ yellowish *Loam*, you have a blue Clay  
“ inclining to Marle, which is about a Yard  
“ thick ; beneath this is a Yard of whitish  
“ Loam, and then a deep-blue Marle, soft,  
“ fat, and soapy, 6 Feet thick, only at about  
“ 2 Feet thick it is parted by a *Marchasite*,  
“ about 6 Inches thick : It is to be noted that  
“ these Beds of *Stone* and Marle run horizon-  
“ tal, whereas the *Strata* of *Coal* run slope-  
“ wise.” This is very well represented in a  
Copper-Cut, (prefixed to this *Transaction*) which  
I refer my Reader to, as well as the other cu-  
rious Parts of this Letter ; which tho’ they are  
not immediately useful to my present Design,  
are nevertheless very well worth any one’s  
while to read.

From these Two Accounts, without enu-  
merating the several Relations we might  
have recourse to, we may satisfy ourselves,  
that the several *Strata* of *Earths* and *Minerals*  
in *Coal-Mines*, found in several Parts, even of  
*Britain*, are not always constant and agreeable  
one to another ; and undoubtedly, when we  
dig for *Tin*, *Lead*, or *Copper*, the *Strata* found  
in those Mines do not lie regularly the same in  
one County that they do in another : And even  
the

the hardest of them, at this Day, were once no more than thin *Mud*, little denser than *Water*; so that Bodies of no more Weight than *Shells*, or *Teeth* of *Fishes*, would subside themselves down to the Bottom, or lodge themselves in it: We have Instances enough to prove this from the many kinds of *Shells*, *Fish-bones*, *Bits* of *Plants* and *Animals* found even in Bodies as hard as *Marble*, and almost every Quarry of *Stone*; which *Shells*, &c. could never have been there, if the *Marble* and other *Stones* they are found in had always been of the same Hardness.

But there remains a great Difficulty to determine, (*i. e.*) the Length of Time necessary to ripen each respective kind of *Mud*, so as to bring it to the Hardness of *Marble*, *Freestone*, *Firestone*, &c. But if we examine the Account sent to the *Royal Society*, 1721, of a live *Toad* that was cut out of the Middle of a Block of hard *Stone*, we may reasonably imagine, that Sort of *Stone* could not be longer than 100 Years from its State of *Mud*, to the Time it was taken out of the Quarry, without we suppose that a *Toad* can live longer. We have indeed an Instance of the speedy Consolidation of *Sand*, *Lime*, and *Water* made into a *Mud* or *Mortar*; and whether there may not be found some kind of *Liquid* to mix with *Sand* and *Lime*, which will make them more binding, and expedite their hardening, I leave Architects to consider; but they must take this  
Thought



Thought along with them, that even some *Waters* are more petrifying than others; and that some kinds of *Stone* lying near the Surface, are very hard when they are dug, but decay in a few Years when they are exposed to the Air; while others, which are *softer* in the Quarry, grow *hard*, and *firm*, presently after they are taken out of it.

Dr. *Stukely*, F. R. S. has very judiciously given his Opinion of this matter, in a Letter to the Royal Society, (*Phil. Trans.* N<sup>o</sup> 360.) concerning the Impression of a Skeleton of a large Animal in a very hard Stone, called a *blue Clay Stone*, supposed to be dug out of the Quarries near *Fulbeck*. That Gentleman gives us, among other curious Remarks, the following Article:

“ Sir *Isaac Newton*’s Doctrine of the Attraction of the Particles of Matter, according to the Quantity of its Solidity, Proximity, and Surface, especially that it is infinitely greater in the Point of Contact, upon which depends its Cohesion, and all the Varieties of Physical Action, will easily direct us to a Notion of Petrification. We learn how a proper Degree of Heat or Cold, Moisture, Motion, Rest and Time, promote this Principle, from the common Experiments of ChrySTALLIZATION, and Freezing even before the Fire, and in many Chymical Mixtures. Whence we cannot be ignorant of *Stone* growing in the Quarries gradually, not by any fancied Vegetation, though there is some-  
C “ thing

“ thing like it in *Corals*, but generally by Ap-  
 “ position of Parts to Parts, as is notorious in  
 “ the *Fluors* of subterraneous Grotts and Ca-  
 “ verns; so that we have no reason to doubt,  
 “ but what was *Clay*, *Sand*, or *Earth*, 3000  
 “ Years ago, may now be *Stone* or *Marble*, ac-  
 “ cording to the Proportion of Concurrence of  
 “ such mentioned Causes.”

In the foregoing Accounts of the *Strata* we find some Veins, here and there, of *Metallic* Matter, as *Iron Oar*, for Example: Now, whether at the retreating of the *Water* to their appointed Bounds after the Deluge, these *Metallic* Bodies were equal in Quantity and Perfection, as we find them now-a-days, is a *Query* worth examining: Or whether from a few Particles or Seeds of *Metallic* Bodies falling into a proper *Nidus*, they increased or enlarged: Or else, we may conjecture, that Parts of different Forms happening to mix with one another, agreeable to some Law of Nature, might with, or without the Assistance of some proper Liquid, frame a Body, which Length of Time should ripen into a *Metal*; this, I think, deserves our Consideration. For my own part, I suppose that all the *Metals* now residing in the Bowels of the *Earth*, were not always subsisting in the State they are now in; I imagine they are abundantly increased since they were first created, by means of *Seeds*, or some Method of *Generating*; and this, I think, is not more remote from Reason, than once the *Generation* of *Plants* was thought to be: And even from the first Principle of the  
 Pro-



Production of *Metallic* Bodies, to their most perfect State, I imagine they undergo various Alterations, and have different Degrees of Ripeness, somewhat analogous to the Changes in *Insectal-Bodies*; as for *Example*, Let us take out of 20 several Mines of *one* sort of *Metal*, which will yield *Silver*, an equal Quantity of *Oar*, and refine every Parcel of that *Oar* distinctly, we shall hardly find *two* of these Mines produce the same Proportion of *Silver*, or contain the same Richness *one* as the *other*; which I suppose happens, because *one* is in a riper State than the *other*; perhaps that which is now *Silver*, was *Lead*, or some other *Metal*, 1000 years ago. We may add to this *another* Question: Whether a *Metal* once generated in the Bowels of the *Earth* may not be helped in its Growth, or nourished more or less, by means of Juices (mixing with it) filtering through the *Strata* above it of various Textures and Depths? For I suppose, as the several neighbouring *Strata* of *Earths* or *Stone* are variously composed, or placed about the Vein of *Metallic* Matter, so the Juices or Liquids filtering through them, are of different Qualities, either nourishing to the *Oar* when they mix with it, or destructive to it: And I the rather embrace this Opinion, because it does not seem disagreeable to what the learned Dr. *Woodward*, F. R. S. has laid down in his Celebrated *Natural History of the Earth*.

I suppose likewise, that *Gems*, which are found in the Intervals or Cavities of the several *Strata*, proceed from certain *Seeds*, or fecundating *Particles*, of their respective kinds, which mixing with the Liquids continually filtering through the Pores of the several *Strata*, are by Degrees brought into their Beds, (*i. e.*) those Intervals amongst the *Strata*, and are there chrystallized, and, I suppose, grow larger as they receive additional Increase from the *Corpuscules*, which continually are conveyed by the *Water* into them, and become more ripe or perfect, as they have a longer Share of Time to lie there undisturbed. From the Experiment abovementioned, made on the *Emerald* with Mr. *Villette's* Burning-Glass, whereby it was changed into a Substance like a *Turkey-Stone*, and the other Observation there mentioned, we might also conjecture, that every particular Kind of *Gem* requires a different Degree of Heat or Cold to bring it to its true Consistency and Colour; and then we may suppose, that while any *Gem* is *first* forming, and consequently in a *tender* State, that then a little Difference from the Degree of Heat or Cold it naturally required, would alter its Qualities: But Nature seems to have a special Regard to maintain them always in the same Degree, without Alteration, by placing them in the *Bowels* of the *Earth*, where (if I may so say) they always *breathe* the same constant *Air* without Interruption.

As for *Pebbles*, *Flints*, and such like *Stones*, Dr. *Woodward* supposes them to have been all originally



originally formed and reposed in the *Strata* of *Earth* and *Sand*; and even the *Amber* too, which that curious Gentleman makes a natural *Fossile*, as well as the rest; and the Reason he gives why we find so many of them loose on the *Sea-Shores*, and on the *Surface* of the *Earth*, is, “that by violent Washings of Rains, and  
“ by the *Sea* or other *Water* beating upon  
“ the *Shores*, *Cliffs* or *Lands*, the *Earthy-Parts*  
“ are dissolved and carried away; but the  
“ *Pebbles*, *Pyritæ*, *Amber*, or other like *Nodu-*  
“ *les*, being hard, and not dissoluble, and more  
“ bulky and ponderous, are left behind, divested of their terrestrial Covering.” And indeed I do not find the Growth or Increase of such-like Bodies can be accounted for any other Way, than by supposing them to have had their first Being in the Bowels of the Earth, where they might be regularly supplied with every thing necessary for their Construction and Nourishment; and again, it is so much more obvious, as we find every sort we can name, as well lying in *Strata* under Ground, as exposed upon the Shores and Surface of the Earth. And the Nourishment and Difference of Colours given these Bodies, while they were lying and growing in their several *Strata*, I suppose to be produced by a Cause, nearly the same of that which gives us the different Colours in the Leaves and Flowers of Vegetables; the several Strainers or Vessels which compose Plants, doing perhaps the same Office that the several

*Strata* of *Earths* do to *Minerals* or *Metals*; and as the different Juices passing through the several Veins or Beds of Earth are altered by a sort of Filtration, and varied by mixing with some Mineral-Corpuscules, which would be latent without such Assistance; so these Juices differently strained through the several Kinds of Earth, mixing with some Vegetable Particles, which change their Qualities, produce Difference of Colours in the Leaves and Flowers of the Plants they pass through.

And this is what I shall venture to mention at present concerning *Earths* and *Mineral* Bodies, which, if my Conjectures are right, have a kind of *Growth*, and even a Mode of *Generating* and *Increasing*; and if once we have sufficient Proof of these, we need not scruple to allow them *Life* too, however slow it be: These indeed have no *Local Motion* any more than Plants; but *Animals* that have *Local Motion* are yet analogous to *Plants* in *Generation* and *Circulation* of Juices through their Bodies, and have *Sensation* more than *Plants*: *Plants* then want *Local Motion* and *Sensation* to be equal to *Animals*; but I suppose have only the Powers of *Visible Growth* more than *Minerals*, and of being *transplanted* from *Place* to *Place*, and yet retain the Power of *Growth*; but where must we *transplant* the *Earth* to make it grow, or improve it?



## C H A P. II.

*Of the CORALINE, TRUFFLE, FUNGUS, SPONGE, and such Bodies which possess the first Degree of Vegetative Life, and are seemingly the Passage between Minerals and perfect Plants.*

HAVING taken Notice (as far as my Experience will permit) of *Minerals* and *Metallic* Bodies, that they possess a certain Share of *Life*, or Kind of *Growth*, whereby they attain to distinct Degrees of Perfection, as they have lain *more* or *less* Time in their *natural Beds*; the *Stones* which I have in the last Place taken notice of, have each, according to its Tribe, a Figure or Form, which distinguishes it from *one* of *another* Class; and the Length of Time which Nature takes to form them, gives them at least an equal Share of Time to remain unperishable; so it is likewise observable in *Vegetables*, that as they are more *slow* of *Growth*, so is their *Remain* of longer Duration; but I conceive there is not in Nature any *Vegetable Body* which can have, or ever had, half the Durance of *Minerals*, unless *Coral* may be allowed its Place among *Vegetables*: And it is the different Sentiments of our great Men concerning this Subject, which puts me to some Difficulty in this Part of my Work. It is not allowed by some to be more than a *Petrified Body*, while

some Gentlemen of the Royal Academy at *Paris* pretend to have discovered its *Seed Vessels*, as we may find in the *Memoirs* for the Year 1711. For my own Part, I will not pretend to determine so great a Difficulty, unless I had more Experience in the Matter. I shall only take Notice from its branched Figure, and its Manner of fastening itself to *Rocks, Stones, and Shells*, that it has some Analogy to *Plants*; for in the first Place, if we consider the *Coralines* frequently growing upon our *English* Coasts, the Manner of their rooting in *Stones* and upon *Oyster-Shells*, their Method of branching, and cruusted Substance, I cannot see any Reason why we may not place *Coral* amongst the *Submarine-Plants*. Again, as to the rooting of *Coral* in this Manner, and the Possibility of its drawing Nourishment from Bodies of so hard a Nature, let us look upon the *Sea-Belts*, which sometimes are of that Length and Extent, that I have measured several above 6 Feet long, though the *Stones* they were rooted in, did not weigh above a Pound a-piece: So likewise the *Sea-Weeds*, and *Fuci*, have not always larger Bodies to draw their Nourishment from; but indeed they may probably be assisted in their *Vegetation* by the frequent Returns of the *Sea-Water*, which may serve to fill their more spongy Parts, and contribute to make them swell, as the circumambient Air assists the Growth of *Land-Plants*. Moreover, we find that *Coral* is of different Kinds or Species, as much as any Plant growing upon  
the



the Land; we have the *Red*, the *White*, and the *Black*, pretty common, besides many other more rare Sorts in the Cabinets of the Curious, where I commonly find them accompanied with *Coralines*, the *Sea-Fan*, and other such-like Bodies.

The famous Cabinet of Mr. *Vincent* at *Haerlem* abounds in these Rarities; as does also that of the curious Dr. *Frederick Ruysb* of *Amsterdam*, where I have seen near 60 Sorts remarkably different from each other. Especially in the *first* curious Collection is to be admired a large Branch of the *Red-Coral*, above 1 Foot  $\frac{1}{2}$  in Height, of an extraordinary Value. There is indeed one Thing which we may take notice of, with regard to *Coral*, that upon breaking off any Part of a Branch, we discover the same Star-like Shootings as are found in the *Star-Stones*; and there is seemingly wanting those capillary Vessels which run longitudinally, to convey the *Sap* up the *Stems* of *Plants*; nor do I find by Enquiry, with my best Microscopes, that they have any, which is much the same Case with the Leaves of the *Aloe*, and some other Kinds of *Succulent-Plants*, where we cannot discover any Vessels which run longitudinally through them, and are therefore brittle as Glass. The famous Mr. *Lewenhoeck* of *Delft*, who was justly reckoned the greatest Man in *Europe* for his Skill in Microscopes, has given the World a curious Account of his Observations on *Red-Coral*, in a Letter to the Royal Society, wherein, I think,

are

are several Remarks which may greatly contribute to illustrate this Point, and help to determine whether it is more a *Mineral* or a *Vegetable*. He tells us “ that he has seen small Parts  
 “ of the *Red-Coral* upon a little *Scollop-Shell*,  
 “ and upon a small Fish called a *Horn*, and  
 “ was of Opinion that it did not grow on those  
 “ Bodies, but was only coagulated upon the  
 “ said *Shells*. He then proceeds to give us an  
 “ Account of his microscopical Observations, and  
 “ tells us that he cut off several thin scaly  
 “ Particles, both longitudinally and horizon-  
 “ tally, from the *Blood-Coral*, in order to dis-  
 “ cover the Vessels in them: He observes, that  
 “ in those Parts which he had cut through a-  
 “ cross, there ran such Fibres from the Center to  
 “ the Circumference, as are found in the Roots  
 “ of under-ground Fruits; but that in the other  
 “ Parts he had only a faint View of some ve-  
 “ ry small Orifices of Vessels, and could make  
 “ no perfect Remarks of them, but that it  
 “ seemed to him as if the Parts of *Coral* were  
 “ made up of roundish Particles, such as some  
 “ certain Fruits are composed of; but their  
 “ Roundness was not exactly equal *one* to the  
 “ *other*, but such as might best suit with the  
 “ rest, so as to leave Vacuity in them; (*I sup-  
 “ pose like the Bubbles in Froth of Liquors*)  
 “ and thus, says he, the *Saps* which are not  
 “ in the *Vessels*, are conveyed from one of  
 “ those round Parts to the other, and so serve  
 “ for *Canals*.”

Again,



Again, he supposes that “ *Coral*, whilst it  
 “ was growing at the Bottom of the *Sea*, is  
 “ very soft, and that the *Plants* of *Coral*, or  
 “ their *Branches* being broken off by the *Coral*  
 “ Fishers, the thick Ends of them may acci-  
 “ dentally fall upon a *Stone* or some other Sub-  
 “ stance; and by reason of their Softness, and  
 “ a glutinous Matter they are indued with,  
 “ may very easily be fastened to the *Stone*, and  
 “ then give us Reason to believe it is an Ex-  
 “ creescence from the *Stone*, or other Substance  
 “ we find it upon.”

From this *last* Observation, as well as the  
*former*, I do not see any Reason why we may  
 not place *Coral* among *Vegetables*; for as I have  
 remarked before, that the Brittleness of *Coral*  
 may proceed from the same Cause as that does in  
 the Leaves of *Succulent* Plants (*i. e.*) the Want  
 of longitudinal Vessels, so may the *Coral* partake  
 of other Properties common to *Succulent* Plants,  
 such as that if we only lay upon the *Earth* an  
 Off-set or Branch of *Aloe* or *Sedum*, they will  
 strike Root in due Time without other Trouble;  
 and Shells and stony Substances being to the *Co-  
 ral*, as the *Earth* is to the above-mentioned  
*Plants*, a broken Piece may as well take  
 Root upon *them*, as the others do upon the  
*Earth*.

The *Sponge* is the next which we may con-  
 sider as a Subject leading to *Vegetation*, and is  
 (what I believe is allowed by all to be) a *Plant*,  
 though

though it is indeed seemingly imperfect, if we compare it with others; but its Vessels are so nicely woven into one another, that every Part is equally supplied with Juices as it flits, or is driven from Place to Place upon the *Sea*; it is a Wanderer as well as the *Lens Palustris*, or *Duck-Meat*, which seldom or never fixes its Roots in any solid Body, but strikes them into the *Water* only, from whence it receives its Nourishment. The Figure of the *Sponge* is for the most Part globular, but without any great Exactness; it is composed of Parts rather like the *Pith*, than any other Part of a Plant, is wanting of Leaves, and has not either Flowers or Fruit that I can yet discover. There are relating to the *Sponge* several Kinds of *Spongoids*, which are ramose or branched; but the Texture of their Parts are near the same with the common *Sponge*.

The next following these, and but little more perfect, seemingly, either in Figure or Parts, is the *Truffle* and the *Puff-Balls*. The *Truffle* is of *two* Kinds, as Mr. *Tournefort* informs us, the one *round*, the other *oval*; but the fleshy Part of both these Kinds is of a much closer Texture than the *Sponge*, and each of them grow commonly about 6 Inches under Ground in the Woods of *Italy*, *France*, and several Parts of *England*, and I am informed have their *Seed-Vessels* towards the Center, in the most fleshy Parts; but as yet I have not been able to discover any, but refer my Reader to



to the Account given of this Tribe of *Plants*, by the curious Mr. *Geoffroy*, in the *Memoirs of the Royal Academy of Paris*, for 1711. I am apt to believe the *Truffle* is not unlike the *Puff-Ball*, as to its Manner of *Growth*; that is, in the first Place its *Flesh* is pretty firm, and by Degrees, as it becomes more ripe, its Inner-Parts change to a Kind of *Dust*, as we find in the *Puff-Balls*, which grow so plentifully upon Commons and other Pasture-Grounds, whose *Dust* I should rather suppose to be the *Seed*, than be inclined to look for it in them while they are in their growing State. Of the *Puff-Balls* I have likewise observed one sort growing in the Shape of a *Pear*, commonly under *Crab-Trees*.

After these we must take notice of those of the *Fungus Tribe*, which are yet without Caps, but seeming more constant and regular in their Figure than those already-mentioned. There are two Kinds which resemble Branches of *Coral*; they are common in *Mossy-Grounds* in *England*, and differ only in the Colours of *yellow* and *white*. After them the *Cap Mushrooms* cut on one Side, such as the *Fungus Sambucinus*, or that which is found growing about the Roots of the *Alder-Tree*, and some others nearly allied to it, which are of an *Orange Colour*.

Next are those Kinds of *Fungi* with *Stems* and *Caps*, which vary their Figures as they become more replete with Juices; these begin to shew us some Parts, which we may naturally

expect to find in *perfect Plants*, as *Roots* and *Vessels*, which run longitudinally, and compose the *Stem*, from whence the *Cap* receives its Nourishment till it is fully explained, as may be easily discovered in the common *Mushroom* or *Champignon*, without the Help of a *Glass*, as well at its first Appearance in the *Button*, as when its *Cap* is fully spread : The *Chives* within-side of the *Cap* have been by some taken for the *Seed* ; but I do not find, with the greatest Care, they can ever be made to *germinate*.

As to the *Champignon*, which is so much esteemed for its excellent Flavour and delicious Relish, it is propagated with great Facility in the Gardens about *Paris* ; but the Gardeners there, have no regard to the *Chives* which I have before-mentioned ; nor do they believe there is any such Thing properly as *Mushroom-Seed*, but chiefly rely upon the Manner of making Beds for them, and placing here and there, in those, Beds small Pieces of *Moldy-Soil*, found commonly in old Dunghills, which is accounted better, as it abounds with *White*, Cobweb-like, *Veins*, running through it. And it is observable that the *Moldy-Soil* I mention, after lying 3 or 4 Days in the Bed, becomes as it were a Leaven to the Whole, by shooting out its Cobwebs over the greatest Part of the Surface, and at length runs into Clusters of small *White-Knots*, which come in the End to be perfect *Mushrooms*. To make these Beds, they provide



vide three or four Cart-loads of Horfe-dung, well cleared from the Straw, and toss it up in an Heap to lie for 15 Days; then they mark out their Bed 3 Feet wide, and of that Length as may employ the Dung to lie near a Foot  $\frac{1}{2}$  thick, laying the Sides sloping in such a Manner, as that the Top of the Bed may be brought to a Point or sharp Edge, like the Ridge of a House, when it comes to be raised 3 Feet high; which must be done with Dung, prepared, as before, 15 Days after the first making or laying of the Bed.

Immediately after the *first* Layer of Dung is wrought, it must be covered, the Top and Sides, with Horfe-litter to lie upon it undisturbed, till we lay on the *second* or last Course of Dung, and then the whole Bed must be coated an Inch thick, with fine Earth, and beat down gently with a Spade, having a strict regard where the Line runs between the *two* different Layers of Dung, along which there must be buried about an Inch deep some small Pieces of the Moldy-Soil as big as *Walnuts*, at a Foot Distance, and then the whole carefully covered with Horfe-litter: From this Management we may expect a large Quantity of *Mushrooms* in a Fortnight after the Bed is completed, and will continue to produce every Day for a Month or five Weeks.

In the gathering of this Dainty, the *French* Gardiners always take care to pull them up with their Roots, pressing the Earth down gently

gently upon the Place they draw the *Mushrooms* from, and covering it with the Litter immediately ; they are likewise very curious to observe, that no broken Part of a *Mushroom* be left on the Bed, which would breed Worms, and destroy the young Knots of *Buttons*, which are coming forward. In the Winter they lay up great Parcels of the Moldy-Soil in dry Places, for their Use at different Times ; and they have this regard to the making of their Beds in the Summer, that from *May* till *September* they lay the Foundations of them 8 or 10 Inches below the Surface of the Earth.

Of these *Cap Mushrooms* there are some more substantial, others more fugacious, some edible, others poisonous ; but to take them together, they are a very numerous Family. The curious Mr. *Dandridge* (to whom I have been obliged for many Notes and Observations mentioned in this Work) has now by him the Paintings or Figures of above 100 Sorts, which he has collected in *England* ; and I am persuaded that there is hardly any Nation which does not afford as many different Kinds in Proportion, considering the Drawings I have seen in the curious Cabinets Abroad. The Times of their natural Growth, are in the Spring, and Autumn.

We may note, that the Moldiness upon Liquors, and such as appears upon Confections and Pickles that are damaged, is of this Tribe : They are Multitudes of small *Fungi* or *Mushrooms*,



*rooms*, which are of that quick Growth, that in about 15 Hours one single Point will spread a quarter of an Inch over the Surface, as I have observ'd with a Microscope.

*Explanation of the Figures relating to Chap. II.*

PLATE I. Fig. I. *A Branch of the Red Coral.*

Fig. II. and III, *Branches of Coralines.*

Fig. IV. *The Sea-Fan.*

PLATE II. Fig. I. *The Truffle.*

Fig. II. *The Button of the Mushroom,  
with its Plant fully perfected.*

### C H A P. III.

*Of PLANTS and SUPER-PLANTS, what is most remarkable in them.*

WE have given an Account of those Vegetables which seem to be the most imperfect, as to their want of Parts; but they are indeed more speedy in their Growth than those *Plants* which have the usual Ornaments of *Leaves, Flowers, and Fruit*, or such as we shall find treated of in this Chapter. *Mushrooms* however are certainly perfect as to themselves; but the more common Knowledge of *Trees, Herbs, and Shrubs*, may give us room to think, that whatever Vegetable is wanting of the Ornaments these possess, is not perfect. For my own part, I think it no small Pleasure that Nature is so extensive and variable in her Works, that a bare Discovery of them is more than we can attain to; and that the Mind of Man,

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which

which naturally loves Novelty, has the grateful Opportunity of being placed in the midst of such a boundless Variety. With regard to Life and Growth, the Unskilful are apt to judge, that Parts of the *same Kind* must equally reside in all *created Bodies*; but if I may venture to give my Opinion concerning that Case, it is, that whatever *Vegetable* or *Animal* is wanting of *half* the Parts or Ornaments that we find in *others*, those seemingly *Imperfects* have a double Power of acting from every Part they contain, so that *two* Parts in *them* perform as much as *four* in the *others*; which may perhaps be the reason that *Mushrooms* are of a quicker Growth than those *Plants* which we stile the most *Perfect*.

The *Plants* which I think most properly follow the Tribe treated, of in the foregoing Chapter, are *first*, The *Rush* Kind, or *Funcus*, of which there are many Sorts, some larger, others lesser, which chiefly distinguishes one Kind from another, all of them consisting of green spiral Stems, which respectively bring forth Bunches of Flowers that end in *Seed*, but have no *Leaves*. They may be rather accounted *amphibious* Plants, than Inhabitants of the Waters, seeing that they grow as well as on the Land, if it be tolerably moist, as in the Waters.

These may be succeeded by the *Echinomelocactus*, or *Melon Thistles*, which are *Plants* without Leaves, and are only guarded with *Thorns*.

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The *Melon Thistles* never branch, unless they are cut, as I have observed in *two* Kinds of them: The large Sort, which comes commonly from *Nevis* and *St. Christophers* in the *West-Indies*, by losing its Top, or Crown, puts forth young Heads, which may be taken off and planted for Increase; and so likewise the smaller Kind, which comes from the *Cape of Good Hope*, will do the same. The first of these I have seen in the State I mention in the Royal Gardens at *Hampton-Court*, and the latter in the Physic-Garden at *Amsterdam*, from which Place I brought several young Plants. It is remarkable, that in both these the Blossoms barely appear through the Skin or Covering of the *Plant*, and the Fruit always remains hid within the *Plants* till it is full ripe, and then bursts forth on a sudden, which is not common in other *Plants*. These *two* are described in Mr. Ray's *Historia Plantarum* and in the *Hortus Lugduno-Batavus*, and are engraven in my *History of Succulent Plants*.

The next, is the *Torch-Thistle*, a *Plant* of an extraordinary Face; it is wanting of *Leaves*, but in other Respects coming nearer the Perfection we look for than the former. These shooting out their Branches freely, are all guarded with *Spines*, and bear large *Star-like Blossoms*, which do not open till the Fruit is full grown, after the Manner of the *Opuntia* or *Indian Fig*: The largest Kind of them is that which we have so common in our Green-Houses in *England*, and is engraven in

the *first* Decade of my *History of Succulent Plants*: This I have seen near 20 Feet high in the Royal Garden at *Paris*; and at *Hampton-Court* there is another sort with a *White* Rind or Skin, which, like the former, grows upright, but with less Luxuriancy. The *first* of these I call *Cereus erectus maximus Americanus hexangularis, Flore albo radiato*, or, *Great Upright Torch Thistle*: The second, *Cereus Americanus octangularis Spinis albicantibus*, or, *Great White Torch Thistle*. At the Physic Garden at *Amsterdam* they have 3 or 4 different Kinds of the *Upright Cereus*, which I have not seen elsewhere. Of this *Tribe* there are likewise some *Creepers*, which are jointed, and run upon the Ground: Their *Thorns* are commonly small and tender, and the young Shoots are for the most Part furnished with voluntary Roots, which lay hold of the *Earth*, or *Barks* of Trees, as they happen to fall. One sort has a triangular *Stem*; the other has its *Stems* in 6 *Ribs*. The *first* is engraven in my *first* Decade of *Succulent Plants*; the *other* is in my third Decade. To these we may join the *Euphorbium*, and some other *Tytbimals*, which are yet without *Leaves*; they shoot their *Stems* upright, are guarded with *Thorns*, and differ from the foregoing *Plants*, in having a *Milky-Juice*, and *Flowers* and *Fruit* of small regard. Dr. *Comelin* has given us very good Cuts of many of them in his *Hortus Amstelodamensis*.

The *Plant* succeeding the *Euphorbium* is the *Opuntia* or *Indian Fig*, which is the *first Plant* that



that attempts to make Leaves, but in such a Manner as may easily slip the Observation of the Curious. Mr. *Rand*, F. R. S. a most ingenious and learned *Botanist*, was the first who informed me of them; they appear only upon the young *Stems* whilst they are perfecting their Growth, and afterwards are supplanted or followed by Knots of *Spines*. Of this *Tribe* I have seen about 13 Sorts growing in *England*, which I design to describe in my *Decades* of *Succulent* Plants; they are all very full of Juice and Pulp, shooting *Stem* out of *Stem*: It is from one of these Kinds that the *Indians* gather the *Cochineal*, which I shall mention at large in its Place.

The *Fig-Tree* may next follow the *Opuntia*, as the Fruit is always perfected in its Parts before the *Blossom* is to be found. What I mention concerning the Blossom of the *Fig*, or Manner of its *Flowering*, I have not myself yet seen; but take the Account from my Friend Monsieur *Geoffroy*, of the Royal Academy at *Paris*, who has given a large Description of the *Flowers* of it in the *Memoirs* of the *Royal Academy* of *Sciences* at *Paris*, for the Year 1712. That Gentleman, upon the Foot of what Mr. *Moreland*, myself, and some others, have advanced, concerning the *Generation* of *Plants*, or the Manner of setting their Fruits, has given a large Account of such Parts of Blossoms in the *Fig* as are necessary in Nature to perform the *Office* of *Generation*: He tells us, that “ all the Parts

“ required to do this Work are within the *Fruit*  
 “ of the *Fig*; those which are *Female* lying to-  
 “ wards the *Bottom* of the *Fruit*, and the *A-*  
 “ *pices* or *Male-Parts*, which produce the *Fa-*  
 “ *rina fecundans*, are situate towards the *Top*.”

He has given us very good Figures of them in general, and in particular, both from *Natural View*, and with the *Microscope*, which I shall leave the Curious to examine; and in the meanwhile, as I have had Occasion to mention somewhat relating to the *Generation* of *Plants*, I shall entertain my Reader with an Accurate Essay upon that Subject, which was communicated to me in the Year 1719, by that excellent Physician Dr. *Antoine de Jussieu*, Professor Royal of *Botany* at *Paris*, entitled,

*The Analogy between Plants and Animals, drawn from the Difference of their Sexes.*

**T**HAT *Plants* and *Animals* are analogous, we may be convinced, if we only consider the *Manner* whereby they receive their *Nourishment*. That sort of Life, which the antient Philosophers observed in *Plants*, was accounted by them so nearly the same with that in *Animals*, that they did not scruple to call it a *Soul*, but has since been more reasonably termed *Vegetation*.

The Comparison that has been made between the Structure and Use of the *Bark* of *Plants*, with the *Skin* of *Animals*; of the *Tubes* through which the *Sap* is conveyed through the *Trunk* to the *Extremities*, with the *Arteries* and *Veins*; the



the Resemblance of the *Ramifications* of those *Channels*, which the *Blood-Vessels* and *Lymphatics*, has given Occasion to *Cesalpinus* and other illustrious Authors amongst the Moderns, who have studied the *Anatomy* of *Plants*, to establish this System.

We may yet advance this Opinion much farther, if we consider the *Nature* of *Plants*, and how they may be distinguished as *Terrestrials*, and *Aquatics*, and thereby agreeing with the *Animal Kingdom*. We may also compare the Solidity and Duration of *woody* and *vivaceous Plants*, with the Strength and Length of Life in *Quadrupeds*. We may likewise observe the Similitude between the *Capillary* and *Fungous Plants*, and the short Remain of such as are *Animal*, with the Imperfections attributed to *Insects*, and the Shortness of their Lives: And to this we may add another Remark, That among *Plants* there are *two* sorts of *Aquatics*, which, like Fish, are either distinctly Inhabitants of the Salt or Fresh Waters.

As there are *Amphibious Animals*, so is the *Vegetable Kingdom* also furnished with *Plants* that have Parts which live as well out, as within the *Waters*.

But as these general Observations, which are founded upon the Structure of the *Organs*, and upon the Mode of *Growth*, have been already discussed by so many Physicians, that there is no room left for Doubt; I shall make it my Business to establish another kind of A-

greement betwixt *Plants* and *Animals*, by more particular Observations, drawn chiefly from the *Diversity* of *Sexes*, and from the Conformity and Uses of those Parts which are to be distinguished in them, for the perpetuating their *Species*.

It appears that the Antients had some Notion of this Distinction of *Sex* among *Plants*, as we find in their Writings that some have given the Quality of *Male*, others of *Female*, to certain *Vegetables*; but the more I have taken Pains to examine into the Reasons they had to establish this *Difference* of *Sexes*, so much the more I find them out of Reason; especially when I discover that they have given the *Feminine*-Character to some *Plants* for the sake of their beautiful *Flowers*, or from the Port or Appearance of the whole *Plant*, as in the *Perry* and some others; or else they had established the *Masculine*-Gender from the Conformation of the *Roots*, *Fruits*, or *Seeds*, as they were nearer the Resemblance of the *Male*-Parts of *Generation* in *Animals*, as in the *Orchis*, *Mercury*, *Hemp*, &c.

But the Chief among modern *Botanists*, *Malpighius*, *Grew*, *Ray*, and *Camerarius*, have greatly improved upon the Hints given by *Cesalpinus*, by marking out to us in a particular Manner the *Distinction* of *Sexes*, in the Description of certain Parts which perform those Functions.

I shall



I shall not in this Place enter upon the late Proposition of Messieurs *Geoffroy* and others, who in the Description they give us of the *several* Parts of a *Flower*, tell us, that the *Dust* which falls from the *Apices* of *Flowers*, is the *Germ* of the *Plant*, or *Embryon* of it; since this System is subject to the same Difficulties with that of the *Generation* of *Animals*, supposed to be affected by the *Worms* or *Animalcules* in the *Male-Seed*.

Nor do I pretend to assign any Reason why Nature has observed so much Regularity in so many different Figures, as we find in the *Farina* of each respective Kind of *Plant*, with the help of *Microscopes*; since Dr. *Grew*, who was so careful in his Observations of this Nature, and Monsieur *Geoffroy*, who is a diligent Follower of our ingenious Countryman, have neither been able to find them out.

I shall only take upon me to compare the *Exteriors* of *Plants* with *Animals*, as far as it regards their *Sexes*, wherein this *Difference* of *Sex* in *Plants* consists, and the Manner of observing it.

As the *Flower* is that Part of a *Plant* which contains the *Organs* for its *Generation*, it is necessary to determine what Idea we ought to have of it, and not to fall too hastily into the enormous Opinions of some, who believed with *Malpighius*, that their most essential Parts were no more than *Viscera* appointed for separating the excrementitious Juices. I am

I am of Opinion, that what we ought properly to call the *Flower*, is the Assemblage of little Threads, to which the *Botanists* have given the Name of *Stamina*, and are terminated at their *Tops* by *small Caps* or *Purses* called *Apices* or *Chives*, which generally have double Openings, from whence flies out the fine *Dust* which ripened in them.

The *Stamina*, which I have just now mentioned, are either encompassed by a single or double Furniture, either of *one*, or of *many* Pieces, consisting of *one* or of *various* Colours, which have hitherto been called *Leaves*, but may rather bear the Name of *Petals*, to distinguish them from the common Leaves of *Plants*, which are generally *Green*, as well as those which serve for an outward Coat to the *Petals*, and known by the Name of *Calyx* to the Flower.

These *Stamina* encompass, for the most Part, a Body of a different Figure, either single or composed, which is either the *Embryo* of the *Fruit*, or a *Tube* terminating like a Trumpet, to either of which the Name of *Pistillum*, or *Pistil*, is indifferently given.

This Description I conceive is exact and full enough to give us a quite different *Idea* of the *Flower* than what we have hitherto received, and may oppose the vulgar Opinion, that every *Body* of *various-coloured Leaves* is a *Flower* or *Blossom*; instead of which, the curious Observers of Nature cannot miss the Observance  
(besides



(besides the *Petals*) of all the other Parts which we have just now mentioned ; and from the instant they behold them, must of necessity perceive their Uses from their Structure and Disposition, but more especially when they have Opportunity of observing their several States and Changes at different Times,

We may conclude then that the *Secret* of *Generation* is neither to be found in the *Root*, *Trunk*, or *Leaves* of a *Plant*, but only in the *Garniture* of those *Organs*, which we have observed the *Flower* is composed of : Since we do not find in any other Part of *Plants* those *Organs* which so well agree with the Parts of *Generation* in *Animals*, or are so useful and necessary to perpetuate their Species. It seems as if Nature, who has hid from us her Manner of Working in the *Generation* of *Animals*, is more inclined to open that Mystery to us in the *Vegetable* Kingdom, since the Means she makes use of, with regard to the *Generation* of *Plants*, is more open, and may be more easily observed.

In effect, what can more resemble those *Organs* which constitute the *Male-Sex* in *Animals*, than those which characterize the same in *Plants*? What Agreement is in their Functions ! Those little *Caps* which make the *Chives* of the *Stamina*, the *Farina* which they inclose, and is so exquisitely prepared as a proper Matter for *fæcundating* the *Germ* ; and again, those Trumpet-like *Tubes*, which are stiled *Pistils*, situate in the Center of the *Stamina*, for the more  
easy

easy Reception of the *Dust*, which is the Offspring of the *Apices* or *Chives*; the Springs which open them, and the Manner of their flinging abroad this prolific *Dust*: Do not these sufficiently set forth the beautiful Simplicity that Nature observes in her Works?

If we could find modest Terms to express the Care and Precaution which Nature takes to succeed in her Work of *Generation* in *Animals*, what Agreement and Uniformity should we not find with that she makes use of in the *Generation* of *Plants*? The Usefulness of the *Petals* which encompass the *Apices* to press them towards the *Pistillum*, so that their *Dust* may fall in great Abundance into it; as likewise how necessary they are to protect those tender Parts from the Injury of the Wind, may still afford us fresh Matter of Admiration.

It is easy to judge, from the Function of the *Pistillum* which receives this *Dust*, that it does the Office of the *Parts* of *Generation* in the Female *Animals*; and that what we have before observed, as far as the *Intromission* of the *Dust* into the *Pistillum*, agrees well enough with the *Conception* of the *Fætus*.

The Nourishment and Growth of the *Embryo* Seed after its *Germ* is made *fœcund*, is agreeable to the Growth of the *Embryo Animal*; the Fruit which encloses it, whether it be *Membraneous*, *Ligneous*, &c. or whether it be in the Form of a *Capsule*, *Cod*, or *Siliqua*, or is divided into *few*, or *many*, Cells or Lodgments,



ments, that *Fruit* (as *Malpighius* observes) serves as a *Matrix* to the *Seed*.

From this Description of the *Parts* of a *Flower*, and the Observations upon their Uses, we may draw *two* Consequences.

The *first* is, That those *Parts* in *Plants* which may be termed *Flowers*, are those which perform the *Office* of *Generation*.

*Secondly*, That after the same Manner as in the *Animal* World, we distinguish between the *Males*, *Females*, and the *Androgynous*, we likewise discover those *Distinctions* of *Sexes* in *Plants*, which Dr. *Grew* has already touched upon.

We may then conclude that a *Plant* may be termed *Male*, when its *Stamina* do not encompass any *Pistil* or *Stile*; or that the *Stile*, if it has any, is barren, or does not inclose an *Embryo-Seed*: Of this kind, are those Strings or Bunches of *Flowers* which we call *Catkins*, or *Julii*, and the false Blossoms of *Hops*, *Hemp*, *Mercury*, and some others.

On the contrary, the *Female* is easily known by its *Pistils* or *Stiles*, which are not encompassed by *Stamina*, but only guarded with *Petals* or other *Membranes*; and yet are fecundated by the *Dust* of *Male* Flowers, which either grow upon the same Plant, or upon others of the same Race. This *Fæcundation* is done by the Help of the Wind, which conveys the prolific *Dust* into the *Tubes* of the *Pistils*, when they are advanced to a fit State  
to

to receive it ; as it is observable in the *Walnut*, *Hazle*, *Alder*, *Willow*, *Coniferous Trees*, and *Gourd* kind. *Malpighius* observed these two Distinctions in the *Flowers* of the last mentioned *Tribe*, as we may remark by the Figures he has given of them in his *Anatomy of Plants*.

The certain Mark by which we may discover the *Androgynous* Flowers, is the ranging of the *Stamina* about the *Pistillum*, whose *Base* or *Body* becomes a *Fruit* ; since we have already remarked, that the *Stamina*, which are the *Male* Parts, will fecundate the *Pistils* in the same *Flower*, which Part we have observed is found only in the *Female*. There is this only *Difference* between the *Plants* and *Animals* that are *Androgynous* ; *Plants* accomplish their *Generation* in themselves without the Help of another Individual of the same *Tribe* ; and the *Animals*, altho' they are endowed with *Organs* agreeable to both Sexes, are yet obliged to seek for one of their own Race to couple with. *Plants* for the most Part bring *Flowers* of this last Species, (that is to say) such *Flowers* as end in *Fruit*.

This Discovery is the Result of those Observations which have been made in the *Anatomy* of *Flowers* and *Fruit*, since it has been judged necessary, that those Parts of *Plants* were the most proper to establish their Characters ; and it is not to be doubted but that Time and Industry may disclose to us the *Organs* of the same Uses in those *Plants*, which have been stiled hitherto



therto *Imperfect*, and which will no longer bear that Character when their *Sex* shall be determined.

We cannot in common Justice refuse to give the Honour due to *John Baptist Porta*, for having first observed the *Seeds* in certain *Plants*, which, till his Time, were esteemed *barren*, as in the *Truffle* and *Mushroom*, which has since been confirmed by the curious Remarks of Monsieur *Geoffroy*, Junior; those of Monsieur *Marchand* on the *Agaricus digitatus niger*, and those of Monsieur *le Comte de Marfigli* upon the *Lytrophyton*, in whose *Bark* he has found the *Seed*; and we begin likewise to discover them in many *Marine Plants*, but chiefly in the *Fucus*.

Monsieur *Billerer*, Professor of *Physic* at *Bezançon*, informs me that he has even discovered *Seed* in a *River Sponge*, called *Spongia ramosa fluvialis*.

There is room to believe, that if we were to take a little Pains to examine the *Marine Plants* at different Seasons, we might discover their *Flowers*, or such Parts as acted for them, since Monsieur *de Recumur* and Signior *Michaeli*, Botanists to the Duke of *Florence*, have already discovered certain Parts which might reasonably be esteemed Dependants of *Flowers*.

This *Distinction* of *Sexes* being established in *Plants*, is one of the most considerable Marks of the *Analogy* between *Plants* and *Animals*; but as it is not only by the *Difference* of *Sexes*,  
nor

nor by the Use of the *Organs of Generation*, that we precisely characterize the different *Animals*; so neither must we be persuaded that these Differences in *Plants* can contribute to distinguish their several Tribes; for in many *Plants*, those Parts which mark out the *Sex* are not easily discovered; and in others the *Flowers* are of so short Duration, that we are not always happy enough to find them in a right Condition for Observation.

Thus my Friend concludes his curious *Observations* relating to the *Difference of Sexes* in *Plants*, which might very properly be followed by the *Essays* upon their *Manner of Generating*, written by my *self* and *others*, wherein there are many Particulars which would render this Subject more instructive; but as they are already made public, I shall refer my Reader to them, in the *Memoirs* of the *Royal Academy of Paris*, for the Years 1711, and 1712; and my *New Improvements of Planting and Gardening*, &c. *Part I. Chap. II.* Indeed, since they have been abroad, I have had Opportunity and Time enough to make farther Discoveries; as for Example: With regard to *Fresh-Water Plants*, we may observe of the *Nympeas* or *Water-Lillies*, and the *Potamogatons* or *Pond-Weeds*, (which I have chiefly observed) that in their *Act of Generation*, or Time of *Flowering*, the Blossoms always appear above Water till the prolific *Dust* is ripe, and cast abroad; and as soon

as



as that is over, and the *Pistillum* or *Rudiment* of the Fruit thereby impregnated, it bends itself downwards till it is entirely under Water, and grows ripe in that State. Again, I observe that their *Seeds* always sink to the Bottom when the Fruit is ripe enough to open itself, which shews us the Care that Nature takes to send every *Seed* to its proper *Matrix*; for these *Plants*, however their Leaves may appear to swim upon the Waters, yet their Roots have always hold of the Ground below. We must not however imagine that every sort of *Water Plant* is fastened by its Roots to the Earth at the Bottom of the Rivers or Pools where they grow: Both Kinds of the *Lens Palustris*, or *Duck-Meat*, wander from Place to Place upon the Face of the Waters, without touching the Bottom either with their Roots or other Parts; and I think the *Water Soldiers* do the same: But that may be enquired into by such as live about the *Fens* in the *Isle of Ely*, where they abound.

But it is time I return to my *first Proposition* and *chief Design* of this Work, *i. e. to mark out, if possible, the several Gradations in Nature's Works*, and what Analogy there is between one Part and another; which leads me to the Consideration of those *Plants* that are very visibly indued with all the Parts required, in *Vegetables*, viz. *Roots, Trunks, Bark, Pith, Branches, Flowers, and Fruit*; and they are of three Kinds, *Herbs, Shrubs, and Trees*.

An *Herb* is properly that *Genus* of *Plants*, whose *Stalks* perish every Year, and whose *Foliate* or naked *Roots* put forth every Spring their fresh *Flower-Stalks*: Of these are the *Grasses*, *Primrose*, *Auricula*, *Pink*, *Tulip*, *Ranunculus*, *Anemomy*, *Strawberry*, &c. and these are either *Fibrous* or *Tuberous* rooted, or else have *bulbose*, *apple*, or *knotted Roots*; and may again be distinguished by being *Annual*, or *Perennial* and *Vivaceous*. Moreover, the several *Modes of Growth* which Nature has distinctly given to the several *Kinds of Herbs*, are well worth our Observation. The first are the *Dwarfs*, such as the *Puricula* and *Polyanthos*, or *Cow-slip* *Kinds*, which subsist without Props or Supporters, and form their Off-sets or Increase in *Clusters* close about the old *Roots*: The second are *Dwarfs* likewise, as the *Strawberry* and *Violet*, which increase by sending out jointed Strings from the main *Plants*, that at every Knot take Root as they run along the Ground. The third sort is of those *Plants* which are *aspiring*, but have not Strength of Body to support themselves without Stakes or Props, which they twine round about, as the *Convolvulus*, *Phaseolus*, and some others; which are so strongly impelled by Nature to twist about and embrace every thing that happens to be near them, that as the Loadstone attracts Iron to it, so have I seen *Plants* of this sort change their first Design of Growth from one Point of the Compass to another, to lay hold of Stakes that have been set



a Foot distant from them. The *fourth* is the *Gourd*, and the *Pea* Kinds, which want the Power of twining, and yet have not Strength enough to support themselves; but Nature has provided them with other Means of bearing themselves from the Ground, having furnished them commodiously with *Claspers*, which catch hold of every Thing they can come near. These *Claspers*, though they do not lay hold of the Ground about them to act there as *Roots*, yet I am of Opinion they are not only designed for bearing up, and binding the *Plants* they are related to, to Props, but serve likewise to draw a kind of Nourishment from the Air, which their Mother *Plants* could not live without, and are in that respect analogous to those *Roots* which we find at every Knot of the common *White Water Ranunculus*, which in the Summer only strike into the Water, and undoubtedly receive Nourishment from it, though they have always a main *Root* which strikes deep into the Ground: These *Roots* are, in Appearance, like the Leaves of *Fennel*, and are so very green, that they have given us some room to believe the *Plant* had Leaves of *two* Kinds; but if we consider this *Plant* a little farther, we may observe that it generally grows in standing Pools or Ditches, which about the End of Summer are vacant of Water, and then is left upon dry Ground, where these *Fennel*-like *Roots* take fast hold, and produce *Plants* for the next Year. We may also take notice that they are *Am-*

*phibious*, living as well upon the Land as in the Waters, which is common likewise to the *Mintbs* and some others. And it may be remarked, that the Roots of this *Ranunculus* are perfectly formed before the Water leaves them to shift for themselves to get their Living in a new Element, and are till that Time in a Manner suckled by the Mother *Plant*.

A *Shrub* is that Genus of *Plants*, which, in every Circumstance, but in its Bigness and Duration, imitates a *Tree*; it has Branches of a woody Substance, and is *Perennial*: Of this Race are *Gooseberries*, *Myrtles*, *Furze*, or *Gorse*, *Mesereon*, *Rosemary*, *Lavender*, *Thyme*, &c. tho' some who are over-nice in their Distinctions esteem the latter as *Under-Shrubs*: The *Shrubs* however, without that Distinction, may be reckoned of 4 Sorts, *viz.* such as are compleat *Bushes*, and are able to support themselves without Props, as the several Kinds of *Roses*, *Althea Frutex*, *Gooseberry*, *Caper*, &c. which last is so rare in *England*, that I cannot help taking notice of it in a particular Manner, having myself brought it to Perfection in *England*, without the Trouble of Hot-Beds or Green-Houses; and I believe was the first that has made the *Caper* familiar to our Climate. In the Year 1715, my Friend Mr. *Balle* of *Camden-House*, received some *Caper* Seeds from *Italy*, which I then sowed in the Scaffold-Holes of his Garden-Walls, to imitate as near as possible the Method of their Growth about *Toulonne*, and at the same Time put several



veral of the *Seeds* into a Hot-Bed: The Consequence was, that those which were sown in the Wall-Rubbish shot near 6 Inches the same Summer, and the few that came up in the Hot-Bed were scarce 3 Inches high the *first* Year, although they were housed with the tenderest exotic *Plants*, and those in the Walls stood the Winter without Shelter. The *second* Year those *Plants* in the Walls made Shoots a Foot in Length, while those in the Pots hardly added 2 Inches to their Height. The *third* Year in *April* I cut the Shoots of the foregoing Summer from the *Plants* that were Abroad, leaving only a Bud or two of each near the original *Stem*, which the same Summer made Shoots near 3 Feet long, to the Number of about 40 upon each *Plant*, and put out Buds for Blossoms; but the *Plants* in the Pots did not advance above 2 Inches. The *fourth* and last Year one single *Plant* in the Wall had no less than a Quart of Blossom-Buds upon it fit to pickle, and the *Plant* perfected some of its Fruit. Thus if the *Plant* be headed down in the Spring like a *Willow*, it will every Summer make a beautiful *Bush*, and afford us as good *Capers* as grow in *Italy*.

The *second* Race of *Skrubs* are such as have a natural Tendency to twining or twisting their Shoots about Props, as the *Honey-suckles* or *Wood-binds*, and *Jessamines*, &c.

The *third* Sort have *Claspers*, which take hold of every neighbouring Twig or Stake to support their rambling Branches, and thereby

are defended from the Injuries they might receive by high Winds and Storms: Of this Kind is the *Vine*, and the *Maracoc* or *Passion-Tree*.

The fourth Kind of *Shrub* is that Sort which Nature has furnished with such Tendrils (for climbing) as strike their Points into the *Bark* of *Trees*, and which I suppose help to nourish the *Plants* they proceed from, as well as to assist them in their climbing; and I the rather believe they draw some Support from the Juices of the *Trees* they strike into, because the *Trees* they grow about, seldom or never make such vigorous Shoots as others that are clear of them: Of this Kind are the *Ivy*, and *Virginia Creeper*, with some others.

A *Tree* is that Sort of *Plant*, which, of all others, is the most lofty in its Growth, and has its Parts more robust, firm, and lasting than any Kind of *Plant* yet mentioned: And to these its Perfections we may add, that it enjoys a longer Share of Life than any other *Vegetable*; and those chiefly among *Trees* are of the longest Duration, which are of the slowest Growth.

Among *Trees* we may make the following Distinctions.

First, The *Pomiferous*, or *Apple-bearing*, as the *Apple*, *Orange*, &c. which have their *Seeds* in *Pippins*, or *Kernels*, in the Center of their *Fruit*.

Secondly, The *Pruniferous*, or *Plumb-bearing*, as *Plumbs*, *Apricots*, *Peaches*, &c. which are still called *Stone-Fruit*, and carry but a single  
Seed



*Seed*, covered with a hard thick *Shell* in each *Fruit*.

Thirdly, The *Nuciferous*, or *Nut-bearing* Trees, as the *Wall-nut*, &c. which differ from the foregoing, in bearing *Katkins* and *Female* Blossoms at Distances one from another upon the same *Trees*. They bear one single *Seed* or *Nut* in each *Fruit*, which, like the former, is covered with a hard *Shell*, and upon that has commonly a *Coat* of a fleshy Substance.

The fourth Kind of *Tree* is *Coniferous*, or *Cone-bearing*, as the *Fir*, the *Pine*, the *Cedar* of *Libanon*, &c. whose *Cones* are of a hard woody Substance, containing a single *Seed* under each of their *Squammæ*.

The last I shall take notice of are those which are *Glandiferous* and *Mast-bearing*, such as the *Oak*, *Beech*, *Ash*, &c. which all have their *Seeds* inclosed in single *Shells*, without *Flesh* or *Pulp* upon them.

We may remark in the next Place, that a *Tree* is a Body on which is dependant many Kinds of vegetable Bodies. The *first* are those which cannot subsist without it, or get Nourishment sufficient to maintain themselves elsewhere. The *second* are such as may be taken from it, and made so familiar with the Juices of the Earth, that they strike root and vegetate, till they become as perfect *Plants* as the Originals they were taken from.

The first *Vegetative* Bodies or *Plantulae*, which more immediately relate to the *Tree*, are

the *Stamina* with their *Apices*, found in the Blossoms; these are for the most Part like so many *Fungi* taking Root in the Foot-Stalk of the *Flower*, or else in the Bottom of the *Calyx*: Their Office is to impregnate the *Stiles* of the Blossoms with the *Farina* they produce; and as soon as they have done that Work, they fade and drop off. We may see one of these *Stamina* with its *Apex* and *Root* done by the Microscope, at the End of my *New Improvements of Planting*, &c. Part III.

The *Petals*, or *Flower Leaves*, are also *Plantulas*, almost of the same Kind; their Office, as we have already observed, is to guard the tender *Organs* of Generation from Cold and other external Injuries; these also having performed their Work, drop from their *Mother Plant*: The longest of their Life (as well as that of the *Stamen*) is *two Months*.

In the next Place we come to consider the *Viscum* or *Mistletoe*, which is always a *Super-Plant*, and can never be made familiar enough with the Earth to take root, or grow in it; and can only be propagated, by sticking the *Seeds* upon the *Barks* of *Trees*, into which it strikes its *Roots*, and supplies itself with Nourishment from their *Sap*: The Manner of its making its first *Roots* from the *Seed*, is, by sending out from its Center 3 *Claws*, which fix themselves on the *Bark* of the *Tree* in the 3 Points of a Triangle, and are at their Extremities like the Mouths of *Leeches*, when they are disposed



disposed for drawing in their Nourishment: These fasten themselves on the *Bark* of the *Tree*, and begin to separate at the Center of the *Seed*, as if each *Claw* was to become a distant *Plant*; but a Year or *two* makes us know the contrary; the 3 *Claws* are then swoln or enlarged enough to meet at their Root-Points, and are so strongly united together, that they make the Foundation but of One *Plant*; and the Place of their first joining in the Center of the *Seed* opens and divides, so that there appears 3 distinct Branches spreading from the *Root*; after this it proceeds to blossom, and bear Fruit, and will live to a great Age. It is remarkable that there is but one Sort of *Mistletoe* in *England*, notwithstanding that which grows upon the *Oak* has been the most admired; and I do not find but that the *Mistletoe* of *Apple-Trees*, or any others, have the same Parts with that of the *Oak*, and have also the same Virtue; for the *Plants* which the *Mistletoes* grow upon serve only to them, as the Earth does to any *Herb* that is planted in it, that is, to furnish it with a convenient Supply of Nourishment. And I have not yet observed that the Physicians have made any Distinction between particular *Plants* growing upon *Sand*, *Clay*, *Gravel*, or *Chalk*, &c. because, as I suppose, they think a *Plant* still preserves its original Virtue, let it grow in any Soil; but this will admit of many Disputes: We know that half a Dozen *Grafts* or *Cyons* of the *Golden-Pippin* may be ingrafted upon as many different

rent Sorts of *Trees*, and yet the Properties of the *Golden-Pippin* still preserve themselves in all the *Grafts*, though they have different Kinds of Nourishment from their several Stocks: But an *Oak* planted upon a dry Hill will not shoot a third Part so much as another of the same Kind will do in Clay or a moist Bottom; and the Difference of the Grain of their Wood, or Size of their Vessels, are in Proportion to the Growth of those *Trees*; from whence we may judge that the Juices filtered through the small *Tubes* of One *Tree*, must be twice as fine as the Juices passing through the large *Tubes* of the Other; and then a *Cube* of an Inch taken out of the Solid in the small *Tree*, must contain a different Proportion of Virtue, from a *Cube* of the same Dimensions taken out of the larger *Tree*; but this Case I shall hereafter treat of more at large.

But I cannot leave the *Mistletoe* without taking notice of *two* Things: In the first Place, as to its Method of Growth, the ingenious Dr. *Douglas* has made several capital Discoveries, which he has communicated to the Royal Society, and is yet so observant in the Progress of that *Plant*, that we expect he will oblige us with farther Observations. On the other Hand, (after it has been considered botanically) and my worthy Friend Sir *John Colebatch* has given us a generous Account of its Virtues, in a small Tract sold for 1 s. 6 d. and with the true Spirit of a *Briton*, has put the Key of Life (as



I may call it) in the Hands of those who are troubled with the worst Distempers, I mean *Epileptic Cases*, which sometimes have led Men to that Extravagance, that in former Ages they have been esteemed as mad Men, People bewitched, or possessed with Devils. And these deplorable Circumstances of Mankind may have given Occasion to *two* Things, which are very remarkable ; *first*, That when the *Druids* lived, they had the Knowledge of Diseases which were incident to human Bodies, and had the Knowledge of the *Mistletoe* in this Case, by which they might probably appear as Demi-Gods in the Eyes of the People. *Secondly*, That the *Oak*, which was held as sacred by them, was chiefly the *Tree* that the *Mistletoe* grew upon ; not to mention the other good Qualities of the *Oak* : And from hence it may be likewise, that by Tradition, the *Mistletoe* of the *Oak* is now in Esteem beyond the rest.

We are next to consider such *Mosses* as are found growing upon the *Barks of Trees*, and chiefly upon such as are distemper'd and declining in their Vigour ; for it can hardly be said that a healthful *Tree* ever produces any *Moss*. The *Mosses* which are the greatest Sign of ill Health in *Trees*, are the *Cup-Moss*, and some others which branch like Coral Lines, and a third Sort resembling a Bunch of Wooll : These are all White, and bear *Seeds*, but are not in other Respects so perfect as the *Green Mosses*. The  
Time

Time of their shooting is in *October*, when the Rains begin to fall.

We now come to treat of such *vegetable Bodies* as are depending upon *Trees*; but may nevertheless be made so familiar with the Juices of the Earth, that from a single Part of a *Tree*, they become *perfect Plants*. The first of these are the *Leaves*, which contain in themselves such *Vegetable Principles*, as give them a Power of producing as *perfect Plants* as the Originals they were taken from. For Instance, plant the *Leaves* of *Orange-Trees*, or other *Ever-Greens*, in fresh Earth, they will strike root, and produce *perfect Plants*, if they are well watered, and kept in the Shade, as myself and Mr. *Thomas Fairchild* of *Hoxton*, with some others, have experienced; so that the *Leaves*, besides their Use in helping the *Buds* to germinate while they are growing upon the *Trees*, may be then esteemed perfect *vegetable Bodies*. The *Leaves* of *Albes* being set in like Manner will produce *perfect Plants*; and even the *Fruit* of the *Opuntia* or *Indian Fig*, when it is full grown, being set into the Earth, will strike root and become a *Plant* as *perfect* as the *Mother* it was taken from: By this Method I have often saved several *Plants*.

The *Twigs* and *Branches* of *Trees* are really so many *Plants* growing upon one another; for as they all proceed from *Buds*, or may rather be said to be *Buds* explained, we may thence infer that the *Buds* they came from did in every  
Respect



Respect perform the Office of a *Seed*: The *Twigs* take Root in the *Branches*, and the *Branches* take Root in the *Stem*.

It is to be observed, that all these, taken separately, may be made by some Means or other to take Root; and even the very *Roots* themselves of a *Tree*, being cut to Pieces, and planted after a proper Method, will vegetate and become perfect *Trees*. Dr. *Agricola* of *Ratibon*, in his *Philosophical Treatise of Agriculture*, prescribes several Methods for raising *Trees* from their different Parts, by the Assistance of *Vegetative Mummy*, as he calls it; and I have already tried some of his Experiments, which answer beyond Expectation; the Account of which may be seen in my Preface to the *English Translation* of his Book. He has 4 or 5 Kinds of *Vegetable Wax* or *Mummy*, that he makes use of for propagating all Sorts of *Trees*: His Method is to dip both Ends of his Cuttings, whether of *Roots* or *Branches*, in one or other of these Preparations, and by that Means the Juices contained in each Cutting are preserved and nourished till they are disposed for striking root, and then the *Mummy* cracks and gives way to the tender *Fibres*. I am of Opinion, was this Way to be farther considered, and some Improvements added to that Gentleman's Method, we should not only be sure of making the Cuttings of every Kind of *Plant* strike Root, but forward them extremely in their Growth; as for Example, was I raise *Peach Trees*

*Trees* from Cuttings, I would get together a large Parcel of young Shoots of *Peach-Trees*, about *Midsummer*, press the Juice from them, and afterwards put in a Dunghill, or some other Heatequal to it, to digest for 3 Weeks or a Month; I would likewise burn a large Parcel of *Peach-Tree Branches*, and lay by their Ashes for 3 or 4 Months, or more, till they became almost like Earth itself; of these *two* Ingredients I would make a Paste to inclose the Bottom Part of my *Peach* Cuttings, sealing the Top of each Cutting first with common Pitch, or some such like Matter, and then put them in the Ground, and keep them well watered: I suppose, if Cuttings, ordered after this Manner, strike root, they cannot fail of a vigorous Growth, as the Paste they are inclosed in contains every Thing agreeable to the Nature of the *Plant* it incloses; and so the Cuttings of every Sort of *Tree* may be ordered after the same Manner.

Could we by this, or Dr. *Agricola's* Way, be certain of the Growth of the Cuttings we plant, we should be sure of having such a Collection of *Fruit* as we most desire; for the *Branches* or *Twigs* may be cut when the *Fruit* is ripe upon the *Trees*. This leads me to consider the Use of *Soap*, which I was informed some Time ago has an extraordinary Effect on the Vegetation of *Trees*, by anointing the *Roots* with it.



I was told by a curious Botanist, that, in the Year 1720, he transplanted a *Bay-Tree* of an Inch Diameter in the *Stem*; but for the more convenient Carriage of it from Place to Place, he cut down the *Plant*, and left only 6 Inches of the *Stem* remaining; and at the same Time cleared the Earth from the *Roots*, and anointed them well with common *Soap*; in this State he planted it in a Pot, and watered it every Morning; the Consequence was, as he says, that in one Month it had shot out 3 *Branches*, each about 2 Feet long, out of the hard Wood of the *Stem*. This quick *Vegetation* seemed so extraordinary to me, that I could not help immediately inquiring into the Nature of *Soap*, and the Ingredients of its Composition, which I found to be *Ashes* of *Vegetables*, *Oils* of *Vegetables* or *Fish*, or *Tallow* of other *Animals*: I concluded then that the *Ashes* and the *Oils* of *Plants* might reasonably contribute to *Vegetation*; and the common Custom of manuring Lands in the Western and other Parts of *England* with *Fish* of several Kinds, made me judge that their *Oil* must contribute to the Growth of *Plants*; and the common Method of laying dead *Animals* to the *Roots* of decaying *Trees*, to invigorate them and restore their Health, gave me good Reason to approve of the Use of *Soap*, with which I have anointed some Cuttings, especially of *Vines*, in *June*, which have preserved their *Leaves* fresh and green, and in *August* began to shoot.

But

But besides the Help which *Soap* may give to the *Vegetation of Plants*, I am apt to believe it will be of great Use in the Removal of *Plants* to any great Distance ; for what chiefly gives the Check to a *Plant* in its Removal, is, that the Air shrinks and dries up the Vessels and *Parenchymous* Parts of the *Root*, so that they are not for a long while in a Condition to draw in their *Sap* freely ; but I conceive that *Soap* will help this Case, if the *Roots* are well anointed with it when they are fresh taken out of the Ground, especially in such *Plants* as are Tap-rooted ; and it will be farther of Use in keeping the Air from the *Roots* after the *Plant* is set in the Ground, till the Earth is firmly settled about them. But as I have yet made but few Experiments in this Way, I shall leave it to others to try some few ordinary *Plants* with it, before they run the Hazard of a large Quantity ; for whether it will agree alike with all sorts of *Plants*, I cannot determine.

As we have already taken notice of the most remarkable Particulars relating to *Plants*, we come now to say something of their *Degrees of Growth*, and their *Progression in Weight and Stature*, from the Time they were inclosed in the *Seed*, to the Fulness of their Perfection. In order to this I shall begin with the *Weight* of an *Acorn*, and compare it with a full grown *Oak*, which it may produce ; I suppose about 12 *Acorns*, fresh from the Trees, weigh an Ounce, and an *Oak-tree* in its most perfect State,  
(which



(which I take to be 100 Years Growth) with its *Roots* and *Branches*, may probably weigh about 15 Ton; so that in 100 Years a single *Acorn* weighing one 12th of an Ounce, has increased its Weight 33,600 Pounds, which is 537,600 Ounces, or an Increase of Parts of equal Value with its first Weight 6,451,200; so that one Year with another, for 100 Years, it gained 64,512 Parts, which is 5376 Ounces; for it would be ridiculous to imagine, as some have done, that an *Acorn* that had shot vigorously the first Year, so as to be perhaps 6 or 8 Inches high, should weigh as much as a Year's Growth when the *Tree* is 50 Years old; or that every Year, during the whole Time of its Growth, it gains equal Sums of Weight: No, the Case is quite otherwise, as we find by Experience: The *first* Year the young *Oak* weighs about 3 Times as much as the *Acorn*, and the *second* Year about 3 Times as much as the *Tree* of one Year, and the *third* Year 3 Times as much as the *second*, and so on in that Mathematical Progression, during the chiefest Time of its Growth; not to reckon the Weight or Number of the *Acorns*, which it might reasonably bear, from about its 30th Year to the 100th Year of its Age, which I conceive cannot be less than 100 Bushels, which may probably contain in Number 384,000 *Acorns*; (for reckoning 60 *Glands* to the Pint, which is 3,840 to the Bushel, in 100 Bushels there will be the aforesaid Number) and if we suppose

F them

them to weigh after the Rate of 12 to the Ounce, the whole Amount of Weight will be 32,000 Ounces, or 2000 Pounds. But I have been as moderate in this Computation of the *Acorns*, as in the Weight of the whole Body of the *Tree*, with its *Roots* and *Branches*, which I have only reckoned 15 Ton. I once remember that 4 Sacks of *Acorns* were gathered from one *Tree*, which amounted to 16 Bushels; and then one may reckon 5 Bushels to be the Produce of a good *Tree*, one Year with another, which, for the Space of 100 Years, amount to 500 Bushels, weighing (according to the foregoing Account) 10,000 Pound, and are in Number 1,920,000; so that if we allow the Weight of the *Leaves* and *Husks* of the *Acorns*, which the same *Tree* produced in 100 Years, to be equal to the Weight of the *Glands*, then that *Tree* has drawn Nourishment from the Earth, Water, and Air, in that Period of Time, 524,000 Pounds Weight, which is a wonderful Increase.

In Annual *Plants*, such as the *Cucurbit* or *Gourd* Kind, the Proportion of Weight in the full-grown *Plant*, compared with the Weight of the *Seed*, is much the same with that in the *Oak*; and the progressive Growth of the *Plant* I suppose to be much like that of the *Oak*, in Proportion to the Length of its Life. In the *Gourd* Kind we may reckon a *Seed* to weigh about a 32d Part of an Ounce, which *Seed* coming to explain itself into a *Plant* of full Perfection,



tion, will spread its *Vine* in 6 Months to such a prodigious Length, that I have measured from the extreme Point of one *Branch* to the Extremity of another above 30 Feet, at which Time there were growing on it 5 large Fruit, weighing about 20 lb. a Piece one with the other, and as many small ones as might probably weigh 30 lb. The *Leaves*, *Stalks*, and *Roots*, I suppose, weighed about 40 lb: so that the whole had gained in 6 Months near 170 lb. Weight, which is 87,039 thirty-second Parts of an Ounce more than the Weight of the *Seed*. The *Fruit* of the largest Kind of *Gourd* is of an Egg-like Figure, sometimes 2 Feet in Length, and the Diameter of its Breadth a Foot; and this vast Fruit is not longer than 40 Days coming to its full Growth; now supposing it but 20 Inches long, and 10 Inches thick, it then grows half an Inch in Length, and a Quarter of an Inch in Breadth, one Day with another.

The *Leaves* of the same *Plant*, when they are full grown, measure about 10 Inches over; these, from their State in the *Bud*, till they are fully explained, require about 7 Days; so that in the Progress of their Growth they are expanded about an Inch and an half one Day with another. Now when *Vegetables* grow with this sudden Increase, I see no Reason why we may not observe their Motion with a good *Microscope*; for every one knows (who has been conversant with *Microscopes*) that we have some Glasses which will magnify a simple Point,

such as is not bigger than a Grain of Sand, so as to make it three Inches over, or shew a Diameter of as much; then supposing an Inch and an half is the Produce of 24 Hours, and allowing that an Inch in Length is equal to 50 Points, then in 24 Hours the *Leaf* grows 75 of these Points; and if we allow every one of those Points to measure 3 Inches by the *Microscope*, the Produce of a Night and Day is 18 Feet 9 Inches; so that if we were to fix a *Microscope* over one of these *Leaves*, when the Sun shines upon it, I do not doubt but we might observe the Circulation of the *Sap* in the *Leaf*, and have the Satisfaction of seeing the *Plant* grow, and its Parts move, much quicker than the Minute-Hand of a Clock, and without Pauses or Rests in its Motion.

As the Growth of *Plants* is thus easy to be discerned, and the Circulation of their Juices, and the Mode of their Generating, is now pretty generally received, some unskilful People have also thought that some of them had a Share in Sensation, as the *bumble* and *sensitive Plants*, the *Wild* or *Spurting Cucumber*, the *Seed-Pods* of *Female Balsams*, with others of the like Nature; but this is far from Reason, when we consider that the Fruit of the *Wild Cucumber* never flies from its *Vine* till its Vessels are over-replete with Juices, which is the same Case with the *Seed-Pods* of *Balsams*, whose Parts are so full when they are quite ripe, that the *Pod* bursts open upon the least Touch; but the



the falling down of the *Leaves* of the *humble Plant*, and the closing of those of the *sensitive*, seems either to proceed from the Tenderness of the Vessels, which convey their *Sap* into them, and fasten them to the *Twigs* they grow upon, or else that they cannot bear any Cold or uncommon Motion of the Air. For in a warm Day, when the Air is serene, these *Plants*, if they stand abroad, are not affected by it, or will scarcely give way, though they are touched with some Violence; but if the Weather be cool, they are seemingly declining, and resist the Touch without any Alteration. On the contrary, when they are kept continually under Glasses, and the Sun shines upon them, they do not only decline if they are touched with the Hand, but are subject to the same Alteration by any extraordinary Pressure or Motion of the Air, made by a Fan or Handkerchief at some Distance from them; and I observe that they never appear in a right State of Health, or have their Leaves expanded, from the Time of the Sun's setting till it is risen.

Thus I think I have remarked what is most necessary to be observed in *Plants*, and may be sufficient to give us an Idea of their Share of Life and Growth; they have *perfect Form*, every one according to its Tribe, and may be as easily distinguished from one another, as the various Bodies observable in the *Animal Kingdom*.

*Explanation of the Figures relating to Chap. III.*

## P L A T E I.

Fig. III. *The Echinomelocactus, or Melon-Thistle, growing in Nevis, St. Christophers, and others of the Carribbee Islands, commonly called, in those Parts, Turks-head, or Popes-head.*

Fig. IV. *The Upright Torch-Thistle, growing wild in Jamaica, and other Parts in the West-Indies, near the same Latitude.*

Fig. V. *The Optuntia or Indian Fig-tree, growing in Carolina, and about Florida.*

Fig. VI. *A Shoot of the foregoing Plant shewing its Leaves.*

## C H A P. IV.

*Of Immoveable SHELL-FISH, and of such as have Local Motion; with Variety of Observations upon the rest of the FISH-KIND in SALT and FRESH Waters.*

HAVING taken notice of such *Plants* as are esteemed the most *perfect*, and made mention of the most remarkable Particulars relating to their State of Life and Manner of Growth, I come in the next Place to treat of those *Bodies*, which, like *Plants*, want *Local Motion*, but have such a Share of Animal Life

as



as to afford them the Power of Sensation.

Of these there are the *Oyster*, the *Muscle*, the *Cockle*, the *Barnicle*, &c, which are never capable of removing themselves from their first Station, as far as I can yet learn, notwithstanding we find of them *in* and *about* some Shores or Rocks, where they had not been observed before ; but this happens from the *Spawn* of them, which flits upon the Waters, and is carried from Place to Place by the Winds or Tides.

It is remarked by some curious Observers of Nature, that such *Shell-Fish* as are *immovable* are *Androgynous* ; that is, each respectively possesses the *Male* and *Female* Parts of Generation, so as to be capable of impregnating itself without the Help of another of the same Kind ; which is the same Case with that which I have mentioned to be natural to *Plants*, which are each of them confined to their several Stations, without the Power of seeking at any Distance one of a contrary Sex ; for which reason we may judge that the necessary Parts, for propagating of their respective Kinds, were thus disposed by Nature.

The *Oyster* has its Situation under such a Depth of Waters, as seldom or never to be left uncovered by them ; but the *Muscle* has generally its Situation in such Places upon the Shore, or Rocks, as by the Fall of the Tides they become exposed to the open Air ; and commonly are

found in Beds of large Extent, sometimes covering near an Acre of Ground, as we may find in several Places on our *English* Coasts : The *Cockle* is always bedded in the Sand upon those Shores that are uncovered at low Tides, and are seemingly fed like *Earth-Worms*, which draw their Nourishment only from the Earth or Sand which passes thro' their Bodies ; but *Muscles* and the *Oyster* we often find will feed upon Sea-Weeds when they can come at them ; though I am of Opinion that their most ordinary Food is Mud and the Wash of the Sea. About three Miles from *Colchester* there are little Pits near the River, which receive the Tides at High-Water, in which they place Baskets of *Oysters* newly brought from the Sea, letting them remain about 15 Days or 3 Weeks, to purge themselves from their natural Food, and grow green by feeding upon a sort of *Crow-Silk*, which is in great Plenty in those Pits ; and then they are reckoned in a right State for Barrelling up for the Markets, and are allowed to be much better relished than any other *Oysters* found in our *British* Seas, tho' there are much larger about *Tenby* and *Milford-Haven*. In some Parts of the *East-Indies* there are *Oysters* of that prodigious Size, that a single *Shell* will weigh above 100 Weight : Mr. *Pocock*, one of the Chaplains to the Royal Hospital at *Greenwich*, has one of them in his Cabinet of Rarities. What we may observe more particularly in this Species of *Shell-Fish*, is first, that they have



have no bony Substance within their fleshy Parts; nor do they enjoy the Benefit of Sight, Hearing, or Smelling, that I can yet discover; neither indeed do I think the necessary *Organs* for those Senses can reasonably be sought for in such Bodies as have a fix'd State of Life; the Senses of Feeling and Tasting being sufficient for the Maintenance and Support of them. These enjoy a more perfect Share of Life than *Vegetables*, which have only a Degree of Life, without any Sense that we can yet find out. Again, as the Bodies of these *Shell-Fish*, of themselves, would perhaps be subject to the voracious Appetites of the *Fish* of Prey, Nature has wisely given them Coverings or Cases of so hard a Substance as to secure them from that Danger. These *Shells* have a kind of vegetative Growth, and have also Vessels of Communication with the Animal they contain; so that it seems as if the Juices of the one were necessary for the Support of the other; which Case is well worth the Consideration of the Curious, as it is partly the same in the *Folium Ambulans*, or *Walking-Leaf*, which I shall treat of at large in the Chapter of *Insects*.

There are yet many other Kinds of *immoveable Animals* of the Waters, which I might have mentioned in this Place; but at present I shall content myself with giving but a few Instances of such Things observable in Nature's Works, as may tend to explain to us what Affinity the several created Bodies have one to another,

another, both with regard to their Frame, and their Power of Growth and Motion: And for better Information, shall chiefly draw my Inferences from such Subjects as may be come at with the greatest Ease.

The next I shall take notice of is the *Scallop* and *Pectunculæ*, which last have a perpendicular Motion in the Water, raising themselves from the Bottom in a right Line to the Surface, by flapping their *Shells* with a very quick Motion; and I suppose the *Scallop*, which seems only to be a larger Kind of them, has likewise the same Mode of Motion, which is worthy our Enquiry.

I have just now met with some very curious Observations of Mr. *Leuwenhoek's*, relating to *Muscles*, in the *Philosophical Transactions*, N<sup>o</sup> 336, and especially tending to prove them *Androgynous*. This learned Gentleman first observes that *Muscles* lay their Eggs in Strings, regularly placed one by another upon the Outside of their *Shells*, and that this *Spawn* or *Eggs* continually increase in Strength till they become perfect *Muscles*, at which Time Part of their *Egg-shells* is discoverable upon the outward Covering of the *Fish*, till that Coat is hardened or changed into a firm *Shell*.

The next Observation was made in Winter, upon the *Ovarium* or *Egg-Nest*: At that Season our Author discovered some of their *Eggs* were placed on the Outside of the *Shells*, while others were yet lodged in the *Ovaries*; these  
unborn



unborn *Muscles* had their sharp Ends fastened to the String or Vessels by which they receive their Nourishment. Some Days afterwards he observed 25 other *Muscles* that had not yet placed their *Eggs* upon their *Shells*; from these he took a great Number of *Eggs*, which he examined with the *Microscope*, and found some of them so small, that he could but just observe the Figure of them; from others he took some that were larger, of a brownish Colour, mixed with little Specks; in these *Eggs* he discovered some of the Parts of the little *Fish*, but the smaller *Eggs* are transparent. In fine, having examined a great Number of *Muscles*, and found the *Ovaria* or *Egg-Nests* in them all, he concludes, that every *Muscle* brings forth young ones, laying them not only upon their own *Shells*, but upon those of others; so that sometimes a *Muscle* is quite covered over with *Eggs*. He tells us, that it is his Judgment, after several Observations, that most of the *Shell-Fish* bring forth their Young without the help of *Males*; each particular *Fish* impregnating itself; for that in all those *Muscles* which he had observed, he found in the smallest Particles of their Beards, by the help of *Microscopes*, that in each Part (which was not the 100th Part so big as a common Grain of Sand) there was a vast Number of Motions, which remained for some Time after it was taken off from the Body of the *Muscle*. In these Parts he has several Times observed *Animalcules* swimming;  
and

and the small Parts that lay round about were put into such a Motion, that he says one may be apt also to take them for *Animalcula* ; and this gives me reason to believe that the *Beard* of the *Muscle* may perhaps do the Office of the *Male Part*. But this is only Conjecture, and deserves to be more duly considered.

As to the Food of *Muscles*, he gives us room to suggest that it is the finest Sandy Parts, and some Kind of Sea-weed ; for he has been as accurate in the Description of the Stomach, as he has been in his Enquiry after those Parts which are appointed for Generation.

We shall next treat of such *Shell-Fish* as have *Local Motion* ; such as *Lobsters*, *Crabs*, *Star-Fish*, &c.

The Habitation of the *Lobster* is in Holes among the Rocks, where the Sea never leaves them ; they have a Power of moving forwards with great Nimbleness, either by swimming in the Water by the Assistance of their 8 smaller Legs, placed 4 on each Side, or the Flapping of their Tail, or the Fins lodged under it. These *Fins* are edged with a kind of Fringe, the better to hold for some Time their *Spawn*, which is not much unlike *Cole* or *Cabbage Seed*, but chained together. Its Motion at the Bottom of the Sea, or upon the Rocks, is assisted by its larger *Claws*, wherein they have so much Strength as to resist a Force equal to 60 Pound Weight ; and by means of *Muscles* in those *Claws*, are capable of pinching any thing they can



can lay hold on with that Strength, that it requires a considerable Force to make them quit their Hold; and, as I am informed by some *Lobster* Fishers, will rather lose their *Claw* than part with what they have laid hold of: Which brings to my Mind what is related of them in the *Memoirs of the Royal Academy of Paris*, for the Year 1711, where it is reported, that if one of the larger *Claws* is broken off, and the *Lobster* still remains in the Sea, it will grow again, or be renewed; which is the Reason, perhaps, that we seldom find the large *Claws* of the same *Lobster* both of one Bigness. If this be true, we may suppose that the State of *Lobsters* is partly *Vegetable*, partly *Animal*; for *Vegetables* have a Power of renewing their *Boughs* or *Branches* when they are broken or cut off; but no *Animal* that I know of has the Power of renewing a lost Limb.

To assist them in catching their Prey, they have two Eyes, and two jointed *Antennæ*, which reach a considerable Length before their Bodies, and in which I suppose there is contained their most subtile Sense of Feeling, even so as to give them notice by the trembling of the Waters of the Approach of their Enemies, which are out of the Reach of their Eye-sight; or perhaps to feel out their Food lying at the Bottom of the Sea, which the Situation of their Eyes cannot allow them to discern. For the better Maceration of their Food before it enters the Stomach, their Mouths are guarded by 4 or  
5 Pair

5 Pair of toothed Jaws, each of which has a Power of acting by itself.

I have not yet had Opportunity of satisfying myself, whether there are *Male* and *Female Lobsters*, or whether they act in Generation as *Snails* do; that is, if each respective *Lobster*, in the Time of Coupling, performs the *Male* and *Female* Act at the same Time: For in all the *Lobsters* I have opened in the Months of *June* and *July*, I find either the *Spawn* is excluded from the Body, and lodged among the *Fins* under the Tail; or else I have observed a *Spawn*-like Body (which I suppose to be the *Ovaria*) running through the Flesh of the *Lobster*, from a Place near the Stomach to the *Orifice* under the *Tail-Fins*. But this Matter I shall treat of more at large, when I have had Opportunity of examining it with more Exactness.

The Natural Historians have reckoned near 30 several Sorts of *Lobsters*, all of which are clothed with *Shells*; and by what I can learn, there are not fewer Kinds of *Crabs*, some of them very poisonous: The larger Sorts of them are commonly found among the Rocks, and, like *Lobsters*, are never uncovered by the Waters; but the smaller Kinds are often found upon the Shores at Low-Water. I do not yet know that any of this Race have the Power of Swimming, or have any Parts analogous to *Fins*.

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The *Crab* which I shall chiefly take notice of, is that Sort commonly found upon our *English* Coast : It is like the *Lobster*, with regard to its Number of Legs and large Claws, whose Texture and Parts are nearly the same with those of the *Lobsters*; their Body is placed in the Centre of their Legs, like that of the *Spider*, but their Motion is Latitudinal or Oblique, contrary to that of the *Lobster*, which is Direct: This Side-Motion of the *Crab*, I suppose, happens for want of that jointed Tail to guide it in its Motion, which serves partly as a Rudder to guide the *Lobster* forward. The Eyes of the *Crab* are more prominent from the Body than those of *Lobsters*, and are so situated, that they can turn them to any Point which they are prompted to move to; for which reason I suppose they are wanting of those *Antennæ*, or *Feelers*, which we observe in *Lobsters*; but some remark that their Side-Movement is directed by their *right* Legs, which they say are always larger than the *left*. I suppose the Manner of their Generation is somewhat like that in *Lobsters*, although they want those *Fins* under the Tail for the Preservation of the *Spawn*. For I have observed in the smaller Kind of *Crab*, which I suppose is in most Respects analogous to the larger Sort, that the *Eggs* are preserved in a Knot closely linked together immediately under the Apron, after they are excluded from the Body of the Mother; and the Time of  
their

*A Philosophical Account of the*  
 their Spawning is the same with that of *Lobsters*.

The *Star-Fish* is another *Genus* of moveable *Shell-Fish*, tho' its Motion is trifling in Comparison with the former; and of these there are several Kinds, tho' I have seen but 3 Sorts, viz. the *Stella Marina Major*, the *Stella Marina Minor*, and the *Stella Marina Arborescens*: The Motion of the first 2 is performed by bending their jointed Rays backwards and forwards; but the latter I suppose must be much quicker, if it can make use of all its Ramifications, which are some thousands in Number. The largest of this Kind that I have seen is now in the *Museum* of the Royal Society in *Crane-Court, Fleet-street*. The Mouths of all this Kind are in the Center of their Bodies; and I do not find any *Orifice* for the Discharge of Excrement, no more than for the Service of Generation. So odd a Creature as this is well worth the Contemplation of such curious Persons as live near the Sea, where every Day they have Subjects enough to employ their Curiosity, and improve their Understanding.

I now come to treat of such other *Shell-Fish* as move from *Place* to *Place*, by Means of an undulating Motion of their fleshy Parts out of the *Shell*, after the Manner of *Snails*: Of these there are several Kinds, some of which can swim or creep at their Pleasure; and others only creep upon the Sands or Rocks. The *Periwinkles* or *Water-Snails*, whether in the Sea  
 or



or in the Rivers, have the same Mode of Motion; we may observe them swimming on the Surface of the Waters, with their whole Body and Shell reversed in the Water; so that they seem to take hold of the Air, and to receive that Resistance from it, which common Snails do from the Earth, or other solid Bodies which they creep upon. They have a Power of contracting their Bodies so as to inclose them in their *Shells*, and at their Pleasure to relax their Parts, or expand them to such a Degree, as to fill up twice the Space of the *Shell*. The Flesh of these Creatures is *Viscous*, and of a porous Texture, by which Means they have a Power of adding continually to the Growth of their *Shells*, or reinstating any broken Part of them; for the *Viscous* Matter contained in their Bodies issues out in great Abundance to any fractured Part of the *Shell*, and soon hardens and joins itself with it. So likewise when the Bodies of these Creatures grow too big for their *Shells*, a Supply of the same Juice serves to enlarge their Coverings. I suppose their Generation is much the same with that of *Land-Snails*, which see hereafter.

The Chief of this Class is the *Nautulus*, *Purpura*, *Strombus*, *Murex*, *Buccinus*, *Trochus*, *Concha*, &c. the Beauty of whose *Shells*, with the surprising Variety in their Structure, is as remarkable as the Diversity of Feathering in Birds, or the various Colouring and Spotting of their Eggs. The great Extent of several of these *Shells* is surprising, some of them weigh-

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ing near 10 Pounds a-piece, without the *Animals* in them. But whoever would satisfy their Curiosity in these Matters, may have Recourse to the excellent Cabinets of Sir *Hans Sloane*; the *Museum* of the Royal Society, *London*; Mr. *Vincent* at *Harlem*; Dr. *Ruysh* and Mr. *Albertus Seba* at *Amsterdam*; where they may behold with Admiration the Beauties collected by those learned Gentlemen. But that we may have some farther Account of the Creatures which inhabit these testaceous Bodies, let me once more recommend the Observance of them to those Gentlemen who have the Pleasure of living near the Sea.

I come now to treat of such *Fish* as are Inhabitants of the *Salt* and *Fresh* Waters, that are framed for swimming only, and are of such a Composure and Texture of Parts, as to breathe only an Element as dense as Waters; for the Air to those Creatures is too fine and rarified for them to subsist in; such as is the Case of some *Animals*, which are taken up upon high Mountains; for there the Air is so much thinner than the usual Air of their Breath in their natural Station of Life, that it does not contain nourishing Particles enow for their Subsistence; and has the same Effect upon their Bodies as they would find in the Receiver of the Air-Pump, if the more heavy Parts of the Air were drawn out: So likewise the *Animals* of the Land cannot inhabit the Waters without Suffocation, any more than the Inhabitants



bitants of the Waters can live upon the Land, or in the several Stations of the Air.

As the *Fish* I am now treating of have their Motion and Passage from Place to Place by swimming only, it would be to tax Nature with an Indiscretion to expect any other Parts about them, but what are necessary for such a Life and Motion. We plainly discover, by many Proofs, that the Water is to them of no more Use than Air is to Mankind. Every *Fish*, according to its respective Tribe, has a Food natural to it, as Land *Animals* have, and without that, the Waters are not sufficient to maintain them.

The Food of Fishes is either *Plants* or *Herbs* of the Waters, *Insects*, or other *Fish*; it is for this Reason that they pass from Place to Place at certain Seasons, in Search of their proper Food. I am informed that even *Whales* go in Troops from the most Northern Parts, as far as the Coast of *Guinea*, and other Places near the Line, where the Sea is full of Weed, at a certain Season of the Year, and there couple as *Animals* do, and then in due Time return to their Northern Station. The *Whale* is *Viviparous*, and suckles her Young, which, I am told, never exceed 2 in Number. Some few Years since several 100 young *Whales* were driven on Shore upon the *Irish* Coast; and of late *Whales* have been taken far South in the *Western* Ocean, tho' fishing for them has been

long practised in the *Northern Seas*, as believing it their only Residence.

*Mackarel, Herrings*, and many other Kinds of *Fish*, have their Seasons of coming upon our Coasts, as well to seek their proper Food then in the Channel, and in our Rivers, as to lay their *Spawn*; and I have not heard that any of these *Passing Fish* have been found in our Seas but at the common Seasons. It is likewise to be observed, that the *Fish* of *Passage* swim always in Shoals, and are as punctual to the Times of their *coming* and *going*, as the Temper of the Season will permit: Sometimes a strong Wind or cold Weather will keep them back 15 Days later than their usual Time; and, on the contrary, I have known them come into the Channel and our Rivers a Fortnight sooner than they used to do, when the Weather has been warm, or the Wind sat to drive them in: But it is no Wonder that their Season of *Passage* depends so much upon the Temper of the Air, seeing every Thing which is proper for their Food is equally depending upon the Weather. The Sea or River-Weeds must have a certain Temperature of Air to bring them forward; the *Insects* of the Waters, &c. depend also upon the same Cause for their hatching; and if our *Passage-Fish* are *Fish* of Prey, the *Fish* they prey upon will not run before them, if they cannot meet with necessary Food.

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As to the Time of *running* or *passing* of each particular Kind of *Fish*, it must not be expected that I should give an exact Account of them ; my Observations have not been sufficient to remark the Seasons when the several Sorts of *Fish* come into our Rivers. But if we may believe the curious Observers of *Fish*, they have *two* Modes of Generation ; the *Squameous* or *Scaley* Kind of them lay their *Eggs* or *Spawn* in shallow Water, and the *Milt* or *Male* covers it with a prolific Juice as soon as it is excluded from the Body of the *Female* ; and when the Waters, by means of the Weather, become of a certain Temperature, the *Spawn* hatches at once into little *Fish*, which for a certain Season swim and feed together in Shoals, not caring to mingle themselves with the *Spawn* or young *Fry* of others, till they are capable of shifting for themselves. It is remarkable, that the smaller they are, they delight in the shallower Waters, and as they gradually increase in Bigness make towards the Deep.

The *Cetaceous* Kind for the most Part are said to couple ; and in several Kinds of them we may plainly discover the *Male* and *Female* Parts of Generation. Some of them are *Oviparous*, and others *Viviparous*.

The Number of *Spawn* laid by some *Fish* is almost incredible : The *Roe* of the *Cod-Fish*, for Example, in the Space of a *Cube* of  $\frac{1}{4}$  of an Inch, contains 250 *Eggs* ; and according to that Proportion, the whole must contain

about 1,000,000. The great Mr. *Lewenboek* tells us, that in the Space of a small Sand of the *Male-Seed* of the *Cod-Fish* there are above 10,000 *Animalcula*. Now supposing that every *Egg* or *Spawn* of a single *Cod-Fish* should come to Perfection, and that in 5 Years Time every one of those *Fish* should be capable of producing others, supposing only half of them *Females*, the Increase of them would then be 5,000,000,000; and 5 Years afterward, by the same Reckoning, there would be an Increase of about a thousand *Miriads* of *Miriads*; which Increase, in the Space of 10 Years, from one single *Fish*, would give us room to suppose, that in 1000 Years, at that rate, the *Cod* only so propagated would fill up more Space than the whole World contains. But we are not to imagine that this vast Number of *Spawn* or *Eggs* can all of them be prolific, nor is it without the Hazard of being devoured by other *Fish*, or of being destroyed by other Accidents: If only a 40th Part of that which is laid annually in the Sea comes to good, the Waters would hardly be able to contain its Produce. Nor are the *Fish* of the Rivers and Lakes less prolific, considering their Proportion. A *Carp* does not spawn less than 20,000, and perhaps a *Tench*  $\frac{1}{2}$  as many; and I believe we may lay it down as a general Rule, that the more Enemies a *Fish* has to itself and its Increase, so Nature has taken Care to provide it with such a Capacity of increasing, or propagating its Species, that there is a due Allowance



ance to make good all Losses that may happen.

It is my Opinion, that most Kinds of *Fish* are partly dictated by Nature to shift their Place about *Spawning* Time, as well for the Preservation of their young ones as for the Sake of their Food. And it is observable, that the *Passing-Fish*, after they have spawned, find out some other Station, perhaps because they would avoid those *Fish* which would prey upon them, if they were to stay in the same Place.

The Forms and Texture of the Parts in *Fish* are as various as what we find in the *Vegetable* Kingdom: Every one is provided with necessary Parts to defend itself against, or to avoid, its Enemies. The *Flying-Fish* has Fins of so great a Length, as to do the Office of Wings in the Air for a certain Time, till they become dry, as well as serve them for Conveyance from Place to Place in the Waters: By this Means they avoid the *Dolphins*, who pursue them for Prey. One of these Sort I have delineated in *Plate VIII. Fig. I.* taken from that of our Royal Society. The *Sword-Fish* and *Saw-Fish* I have also taken the Figures of, (from those at *Salter's* Coffee-House at *Chelseä*) to shew what Weapons Nature has provided them with for their Defence; which makes me suppose that they are not without Enemies to prey upon them, notwithstanding they sometimes measure 6 Feet in Length. And, to set aside the fabulous Account of the *Syren* or *Mermaid*,

I have likewise, in the same *Plate*, added the Figure of the true *Mermaid-Fish*, as it is now preserved in Mr. *Salter's* Collection of Rarities.

The *Orbis Echinatus*, and *Lanthorn-Fish*, are also naturally guarded with *Spines* which cover their whole Bodies, so that no kind of *Fish*, be they ever so voracious, dare attempt them. Nor is the *Perch* without its *Spines* in the back Fin, which it can raise up at Pleasure for its Defence, when its Enemy draws near.

But it is not only by these natural Arms or Weapons that *Fish* preserve themselves, or their *Spawn*, from the *Fish* of Prey; they have likewise a natural Cunning, which furnishes them with Contrivance to make themselves Nests or Cases of Shelter for themselves and their *Spawn*; an Instance of which I have lately been agreeably furnished with by the learned *John Hall*, Esq; Serjeant at Arms, who made me a Present of a *Tickleback's* Nest, which he observed the Structure of from near the Time of its Beginning, till it was brought to the Perfection it is in the Figure: It is composed of little *Fibres* of *Roots*, so placed together, as to leave an hollow *Tube* in the Middle, which I suppose was rather composed to lay the *Spawn* in, than for a Lodgment for the *Fish* itself; for the *Tickleback* has a sharp Thorn in its back Fin, which I suppose is sufficient to defend it from *Fish* of Prey; but as they always live in the shallowest Water, so their *Spawn* would be too much exposed to  
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the *Swallows*, or other Birds, which delight to be near the Waters, was it not to be defended from them by some such like Covering. About the End of *May*, or Beginning of *June*, is the Time when these little Builders are at Work. And since we have this Instance of the Contrivance of one Kind of *Fish* for its Preservation, or the Preservation of its Young against Enemies, we may as reasonably conjecture that other Sorts of *Fish* have their respective Methods of building Nests or Shelters for their Security, which is no more than all Birds do, tho' after different Manners. And indeed we do not find any living Creature whatsoever that has not some Sense or other which guides it to the Study of its Preservation: Even the *Cados-Worms* have each respectively, according to its Tribe, a Mode of making its Case or Lodgment after a particular Manner, to defend themselves from the *Fish* which are very voracious of them. One Kind makes its Covering of the Points of *Rasbes*, another of small *Shells*, and a third of fallen *Leaves*, which, by Means of a *Viscous* Matter, they glue and cement together in such a Manner that it is hard to separate them. The three Kinds which I here mention, are taken from the curious Cabinet of Mr. *Dandridge* in *Morefields*, where there are many other Sorts of them among his numerous Collection of *English Insects*.

*Fish* seem to enjoy the Power of *Sensation* as perfectly as any other *Animal*. Their Sight  
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cannot be disputed, and even seems to exceed the Sight of many *Animals* for its Quickness; and I suppose their Tasting and Smelling are not less perfect; for we find most Kinds of *Fish* will take one Bait rather than another, altho' they are composed of several Ingredients, and have no regular Form; which seems to determine that either their Taste or Smelling is more pleasantly affected by one thing than another. But indeed I do not find that the curious Observers of *Fish* are of Opinion that they want any *Sense* but that of *Hearing*; and even they do not determine whether that Sense is absolutely wanting or not: But if I may be allowed to judge from an Experiment I have made upon *Carps* in several Places, I believe it will be allowed that they enjoy that *Sense* as well as the rest.

At *Rotterdam*, in a Garden belonging to Mr. *Eden*, a very curious Gentleman, I had the Pleasure of seeing some *Carps* fed, which he kept in a Mote of a considerable Extent; the Occasion of my seeing these Creatures, was chiefly to satisfy me that they were capable of *Hearing*. The Gentleman having filled his Pocket with *Spinach-Seed*, conducted me to the Side of the Mote, where we stood mute for some Time, the better to convince me that the *Fish* would not come to us till he called them. At length, being desirous to see the Event, he called in his usual Way, and immediately the *Fish* gathered together from all Parts of the Mote in such Numbers, that there was hardly



hardly room for them to lie by one another, and then he flung some *Spinach-Seed* among them, which they devoured very greedily. This alone would have satisfied me that *Fish* had the Sense of *Hearing*; but upon relating the Story to some curious Gentlemen, I was told, that at Sir *William Bowyer's*, near *Uxbridge*, there is a Pond of *Pikes* or *Jacks*, which they call together at Pleasure, and I think is more surprising than what I have mentioned of the *Carps*; for the *Pike* is held to be a more wild, untameable *Fish* than the *Carp*; and as it is a *Fish* of Prey, it has been thought impossible to civilize it, or make it any way familiar with Mankind. There are indeed many Instances of *Carps*, and *Tench*, which will come of their own accord, at certain Times, to some particular Part of a Pond to be fed; but I suppose they have been trained up from the first Year to feed at one Corner of the Pond rather than at another; that is, when one Part of a Pond has been continually supplied with such Ingredients as are proper Food for them, either by means of an accidental Drain, or designedly.

I have this Year taken a large Parcel of young *Fish*, just after hatching from the *Spawn*, and have kept them near 3 Months in Earthen Pans, with a little Earth at the Bottom; the *Fish* are of several Kinds, and do not only thrive, but are now so familiar, that upon my Approach they come in Shoals to the Side of the Pans to be fed: The first Thing I fed them  
with

with was Wheat Flower scattered upon the Water, for the *Fish* were then so small that they could not swallow any Thing larger than a Grain of Flower: At the same Time I gave them fresh Water from the *Thames*, which I suppose was not without some nourishing Parts in it; but now they are large enough to feed upon small *Insects*, and little Bits of Paste made of Flower and Water, which they readily catch at, as soon as I fling it in. Towards the Winter I design to inlarge their Bounds, and I suppose then, with a little Care, I may keep them to their familiar Way of Feeding, where and when I please: For I find it is with *Fish*, as it is with *Birds* or other *Animals*, that the best way to civilize them, is to have the Management of them when they are very young, and by that Means they may be brought to do any Thing within the Bounds of their Comprehension, or that is agreeable to the Structure of their Parts; and their Memory is so constant, that, after this early Impression, they hardly ever forget it. But the Docility of *Fish*, I believe, does not exceed what I have here related.

To consider the Parts of *Fish* more particularly, we may observe that every Kind of *Fish* has its Jaws framed for the taking and macerating of its particular Sort of Food: Such as feed upon *Weeds* and *Insects* have seldom any Teeth; but such as prey upon other *Fish* have 1, 2, or more Rows of Teeth, for the better grinding



grinding their Food. The Gills of the *Cod-Fish* are guarded with Tooth-like Bones, which I suppose are no less contributing to Maceration than Teeth themselves. The *Fins* are in Proportion to the Bodies of the *Fish* they relate to, and serve as Oars to row them from Place to Place, and raise them to any Height, or sink them to any Depth in the Waters, while the finny Part of the Tail serves them as a Rudder to guide their Course. And for the more easy bending of their Bodies, their Backbone consists of very short *Vertebræ*, so joined together, that their Tail may be easily bent up to the Head; and that such bending of their Bodies may meet with no Obstruction from their outward Coat, the *Scales* are so regularly placed in Rows one over another, and covered with such a *viscous* Matter, that they give way without Difficulty to the Motion of the *Fish's* Body, and slide with Facility thro' the Waters.

The *Scales* of *Fishes* are as remarkably different, as the *Fishes* are various which have them for their Covering; and many of them, being examined with *Microscopes*, are of very surprising Figures, some of them not unlike the *Shells* of *Pectunculæ*. All *Fish* indeed have not *Scales*, but such *Skins* as are of a Leather-like Substance, and *viscous* on the Out side; and I think this last Kind are most of them, if not all *Viviparous*, bringing forth their Young perfectly formed. I am assured by many Fishermen,  
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that they frequently take at the *Buoy of the Nore*, about *Christmas*, a *Fish* which they call a *Coney-Fish*, somewhat like an *Eel*; and at *that* Season they are full of young ones, alive, and very nimble in their Motion; and I am of Opinion, at that Season of the Year, which is the Time when *Eels* do *bed*, or *lay* themselves up in the Mud, we might discover the Manner of their Breeding.

The Share of Life which some *Fish* possess is very remarkable, and is somewhat like that we observe in some *Insects*: The *Eel*, for Example, being cut to Pieces, maintains Life and Motion, for several Hours, as if every *Muscle* of its Body enjoyed a distinct Soul, or Spring of Motion whereby it lives, till the Part wanting a Supply of Nourishment is forced to submit. And this is nearly the same in *Plants*, which have in every distinct Part of them (abstracted from the Body) a Power of vegetating, and producing every particular Part which may be found in a full grown *Plant* of the same Kind they were taken from. A *Carp* is likewise possess'd of a very subtle kind of Life, and will move vigorously several Hours after the Intestines are taken out of its Body; and I have even seen one of its Fins move a considerable Time after it has been over the Fire in a Stew-Pan; but I have not observed whether the Heart will beat after it is taken out of the Body, as that of an *Eel* will do, with regular Motion, for above an Hour. I suppose that



that *Fish* are generally long-lived, and that *Carps* especially will live above 100 Years : For in some large Pools or Fleets (as they call them) which have not been fished or looked after in the Memory of Man, there have been *Carp* taken near 3 Feet in Length ; and it is very rare to find a dead *Fish* in any Pond, unless it has been killed by some Wound or other Accident.

Next to an *Eel* I believe a *Carp* will live the longest of any *Fish* without Water ; for it is common to transport them alive in Panniers, with Wheat-Straw, 40, or 50 Miles ; and I once had some *Carp* that lived near 30 Hours without Water. I cannot help observing in this Place what I have often heard of the *Herring*, that it dies as soon as it is taken out of the Sea, because I can affirm the contrary from my own Knowledge. In 1717, being in Company with my worthy Friend *Tho. Balle*, Esq; and some other Gentlemen of *Devonshire*, at the Drawing of a Sein or Net, among other *Sea-Fish* we caught a large *Herring*, which lived in my Pocket near half an Hour : This gave me a Thought of contriving a Method of preserving some of the smaller Kinds of *Sea-Fish* alive, which would be very agreeable to the Sight, and as pleasant to the Palate as if we were to dress them fresh taken out of the Water, when they could have no immediate Opportunity of getting them immediately out of the Sea.

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Were we near enough to the Sea, and upon a Level with it, we might make little Store-Ponds to be fed with the Tides, which would serve to maintain some Kinds of *Sea Fish*, especially if the Water in those Ponds was always kept in Motion ; for we find by Experience, the Motion of the Water is as material as the Saltness of it to preserve Life in the *Fish* of the Salt-Water Race. Witness the Method the Fish-Women in *Holland* take to keep *Plaice* and some other Fish alive in Tubs, by moving the Water continually with Paddles, till all their *Fish* is disposed of ; for if they were to let the Water stand quiet for a few Minutes, the *Fish* would die : Therefore to keep Water continually moving in the Salt Ponds which I here propose, we might place a Couple of Wheels with Trenchers, like those in common Water-Mills, to be turned by the Flux and Reflux of the Waters, and by their Motion produce a continued Agitation in the Water of the Ponds ; or else, where we have the Benefit of a River to turn a Wheel continually, we might make a Bason to hold a small Quantity of Water, by adding to it one fortieth Part of common Salt, *i. e.* a Pint, or Pound of Salt to 39 Pints, or Pounds of Water. Sir *Hans Sloane* kept a *Turtle* or *Sea Tortoise* a long Time in Water prepared after this Manner.

But to return to my Remarks upon the Degree of Life in *Fish*, we may observe that the *Flounder*, and many others, will live a long  
Time



Time after their Bowels, and more noble Parts, are taken out of their Bodies, which is more than we can observe in any of the *Land Animals* or *Birds*; for in them, as soon as the Heart is taken from its original Station, a Struggle or two finishes their Life; which shews plainly that Circulation of Juices in different Creatures is not always promoted by the same Cause, or performed in the same Manner. For no Creature can live any longer than their Juices circulate; and every one allows, that in *Land Animals* the Heart is the immediate Cause of Circulation.

It may perhaps be expected that I should be more particular in this Account of *Fish*, and that I should describe the several Kinds of them; but that is not my Design in this Work; my Business is to give only a general Account of those Remarkables in the Creation, which I know myself to be Fact, and to drop such Hints as may lead the Curious to farther Observations, in order for them to frame right Ideas of the Degrees of Life and Motion in the several Particulars of the Creation. We may indeed observe that there are *Whales* of 21 Feet long, and *Fish* of all Proportions from that Length to an Inch only: And that in some Lakes there are Kinds of *Fish* which are not perhaps found elsewhere: That the enormous Bulk of the *Whale* exceeds all other Creatures upon Earth; and the Smallness of the *Tickle-back* is inferior to any Kind of *Bird* or *Quadrupede*

*pede* yet discovered. But was I to relate every Thing I have heard concerning *Fish*, or other living Creatures, I might swell this to a large Volume, and make myself accountable to the World for a thousand Falsities. Indeed what Informations I have from some particular Gentlemen, who give me leave to back their Relations with their Names, I gladly receive, and publish to the World as so many Instances of their generous Spirits and Curiosity. I confess that I have not read much upon this Head, but avoided those Books which treat of the Subject of this Work, as much as possible, lest I should be too much biaſſed by the Narrations of Authors, who themselves might have been imposed upon. The great *Willoughby* indeed has given us undoubted Truths in his *Treatises of Birds and Fish*, which are generally allowed the best Instructors for such as are disposed to study the Structure and Nature of those Creatures; to which I refer my Reader. I shall now proceed to speak of those *Quadrupedes* which are the nearest related to the *Scaley* Tribe.

*Explanation of the Figures relating to Chap. IV.*

### P L A T E III.

Fig. I. *The Muscle.*

Fig. II. *The Scallop, whose Motion is perpendicular.*

Fig.



Fig. III. *The Lobster lying in its natural Position.*

Fig. IV. *The large Sea-Crab.*

# P L A T E IV.

Fig. I. *The Upper-side of the Star-Fish most common upon our English Coast.*

Fig. II. *The Under-side of the same Fish.*

Fig. III. *The Shell-Fish called the Sea-Horse, found upon the Coast of Italy; taken from the Royal Society.*

Fig. IV. *The Turtle, or Sea-Tortoise, clothed in Shell, the first of the finny Race; drawn from Mr. Salter's Collection at Chelsea.*

# P L A T E V.

Fig. I. *The Sword-Fish.*

Fig. II. *The Saw-Fish.*

Fig. III. *The Mermaid, or Syren.*

N. B. *All this Plate taken from Mr. Salter's Collection.*

# P L A T E VI.

Fig. I. *The Orbis Echinatus; from Mr. Salter's.*

Fig. II. *The Whiting.*

Fig. III. *The Silver Eel, whereby the Difference between the Smooth Fish and the Squameous Kinds may be observed.*

## P L A T E VII.

Fig. I. *The Roach, which may serve to give a general Idea of the Squameous or Scaley Fish.*

Fig. II. *The Flounder, or first of the flat Fish. In this Kind it is remarkable that the Males have their Mouths on the right Sides of their Bodies, and the Females on the left.*

Fig. III. *The Thornback, shewing its upper and lower Sides.*

## P L A T E VIII.

Fig. I. *The Flying-Fish; from the Royal Society.*

Fig. II. *The Nest of the Tickleback observed by Mr. Hall.*

Fig. III. *The Nests or Cases of 4 several Kinds of Cados-Worms found in the Waters.*

## C H A P. V. and VI.

*Of SERPENTS, the CROCODILE, LIZARD, CAMELION, and others of the Scaley Tribe, which are Amphibious, and Inhabitants of the Land; and of FLYING LIZARDS, &c. which seem to be the immediate Passage between the Fish and Bird Kind.*

**A**S I have discoursed of such Creatures of the Waters as are generally clothed in Scales, I can no where so properly introduce the



the Race of *Serpents*, *Snakes*, &c. as in this Place: These seem to possess many Particulars found in *Fish*; as the Manner of placing their *Scales*; their *Eel*-like Motion; but above all, their Degree of Life. As I have taken notice above of the extraordinary Motion of every *Muscle* of an *Eel*, and some other *Fish*, after they are cut to Pieces; so such Motion is no less remarkable in some *Snakes* and *Serpents*, after their Bodies are divided into several Parts. And the Food likewise of our common *Snakes* is much the same with that of our River *Eels*, they both feeding upon *Frogs*, *Toads*, and such like.

Of this Race I do not find above 3 sorts in *England*, viz. the *Snake*, the *Viper*, and the *Slough-Worm*. The first is an harmless Creature, as far as I can observe, though many believe the contrary: For this Year I have had several alive, which have been familiar about the House, without doing any Hurt; though some have taken them into their Bosom. I have heard that what Poison they have lies about their Tongue, but that they lose it the first Dart they make at any Thing they are angry with, and can never recover it again till they get to Water: But if it was so, I believe People would hardly venture to take them up carelessly in the Fields, as I have seen several Times. The *Viper* indeed has a deadly Poison lodged in little Bladders about the Root of its Fangs; but his whole Body besides is a Dainty,

eaten very frequently. The learned Dr. *Tyson* tells us in his Account of the Dissection of a *Rattle-Snake*, *Phil. Trans.* No. 144, that the *Male Viper* has 4 *Penes*, agreeing in most Particulars with the *Penes* of the *Male Rattle-Snake*, which are likewise 4 in Number, although the *Females* of both Kinds have each of them only 2 *Uteri* for receiving them. He conjectures that 2 of these *Male Parts* enter at one Time into one *Uterus*, and spread themselves like the *Pythagorean Y*, that they may the better and more firmly be retained there till they have performed their Duty. He tells us that both the *Rattle-Snake* and the *Viper* are *Viviparous*; but the common *Snakes* we all know are *Oviparous*; their *Eggs* being frequently found in Dunghills.

The same Gentleman gives us a long Detail of the several Parts *External* and *Internal* of the *Rattle-Snake*, which he dissected before the Royal Society, in *January* 1682-3, illustrated with many extraordinary Observations, to which I refer, as well as the curious Cuts which he has prefixed. In Plate IX. of this Work I have given a Cut of one of those *Rattle-Snakes*, now in the Repository of our *Royal Society*; and in the same Plate I have given likewise a Figure of another Kind of *Serpent*, as well to shew the different Frame of the *Heads* of various Kinds of *Serpents*, as to give my Reader the Satisfaction of observing the surprising Variety of Colours, and different Methods of their Scaling.

In



In the Cabinets of the Curious we may find vast Varieties of the *Serpent* Kind ; but I think none of them can be more remarkable than that presented to the Royal Society by Dr. *Mead*, which is above 25 Feet long. The Body in the thickest Part, although it is now dry, measures about 10 Inches Diameter ; and I believe is one of the largest Sorts produced in the *East-Indies*.

Immediately after this Race, follow the *Crocodile*, *Alligator*, *Lizard*, &c. which are covered with *Scales*, like the former, placed conveniently in the *Lizard* Kind, for the easy bending of their Bodies : The Shape of their Heads is agreeable to the Figure of the Heads in *Snakes*, and they are *Oviparous* ; but for the Assistance of their Motion upon the Land, Nature has added to their Bodies 4 Branches or Legs a-piece. Their Habitation is partly in the Waters, and partly upon the Land : The first agreeing with the *Fish* Kind ; and the latter, as well as the Legs they are endowed with, make them Partakers with Land *Animals*.

We have Accounts of *Crocodiles* and *Alligators* of above 20 Feet in Length ; and I am of Opinion that some of these Creatures having been formerly in *England*, has given Rise to the many fabulous Accounts, which have been handed down even to our Times, of *Dragons* ; and this I the more readily believe, because the Skeletons of some such Creatures, or the Impressions of them in Stone, or other *Mineral*

Matter, have been dug up in several Parts of the Kingdom.

The *Lizard* Kind is very numerous; and I question not but there is as great a Variety of them as there is of the *Serpent* Race. Upon *Hamstead-Heath* I have observed a small Sort of them of a *Brownish* Colour, perching upon the *Furze* and *Broom* growing there; and I have heard of a small *Green* Sort likewise in *England*, but have not seen it.

The *Water-Neutes* are almost of the same Figure, and are said by some to be poisonous; though I have handled them very often, without receiving any Injury from them. We have besides these a larger Kind, found commonly in moist shady Places, which are *Black* on their Back, and have *Yellow* speckled Bellies; and these likewise I do not find have any Venom in them. These two last Kinds lay *Eggs* about eight or ten in Number, and the *Crocodiles* and *Lizard* Kind are said to do the same; and none of these, as I can learn, either feed or suckle their Young, but leave them to shift for themselves as soon as they are hatched. The Natural Historians have given us large Accounts of these Creatures, which I refer my Reader to for his further Satisfaction.

The *Camelion* is a Creature, whose Figure is near enough to those of the foregoing Race, to accompany them in this Chapter; but its Life and Habitation is altogether upon the Land; its Skin is shagreen'd, like that of the *Dog-Fish*,



*Fish*, and transparent; so that sometimes one may perceive through it different Colours, as its Body happens to be in a different State. This Creature has been reported to live upon the Air only; but those among the Curious, who have kept them alive, tell us, that their chief Food consists of *Flies*, which they catch by darting out their Tongue with great Quickness. All the *Animals* which I have yet mentioned in this Chapter are said to sleep, or are laid up in the Winter.

The Creature which seems to be next allied to the foregoing Race, is the *Winged* or *Flying Lizard*, whose Shape and Turn of Body, in many Respects, is like that of the small *Italian Brown Lizard*, or that Sort found upon *Hamstead Heath*: The *Winged* Part of it is in Substance much like the *Wing* of a *Batt*, but the Head is different from that of the *Lizard* Race; and the *Pouch* under the Throat I am told contains a poisonous Matter. This Kind of *Flying Lizard*, which I have delineated in Plate IX. Fig. V. was presented me by Dr. *Ruysh* of *Amsterdam*, who received it with other Rarities from the *East Indies*: And the same Kind may be observed in the Cabinets of Sir *Hans Sloane*, Mr. *Vincent* of *Harlem*, Dr. *Ruysh* and Mr. *Seba* of *Amsterdam*.

In the *West Indies* there is another Sort of *Flying Lizard*, different in the Colour and Make of its Wings from the former; and instead of a Bag under the Throat, has a thin Film

Film or Skin hanging down, almost of the Shape of a *Myrtle Leaf*. This and the other Kind is said to be *Oviparous*; and in the Accounts Dr. *Ruysh* gave me of them, it appears that they have each of them the Power of Flight, and generally perch upon *Trees*; which leads me naturally to treat of *Birds* in the next Chapter.

*Explanation of the Figures relating to Chapters V and VI.*

### P L A T E IX.

Fig. I. *The Rattle-Snake from the West-Indies; taken from one of those preserved in the Museum of the Royal Society.*

Fig. II. *A West Indian Serpent; from the same Museum.*

Fig. III. *A Lizard; from Sir Hans Sloane's Cabinet.*

Fig. IV. *The Camelion; from the Royal Society.*

Fig. V. *A Flying Lizard from Amboyna in the East-Indies; taken from Sir Hans Sloane's Cabinet.*

### C H A P. VII. and VIII.

Of BIRDS and FOWLS; as also of the BATT (or Flutter-Mouse) FLYING SQUIRRELS, &c. which seem to be the Passage between Fowls and four-footed Beasts.

I shall now treat of such *Animals* as are clothed with *Feathers*, and in many Respects agree with the last mentioned *Animals*, which



which are, like *Birds*, *Oviparous*, have 4 Branches to their Bodies, and possess the Power of Flight. To which we may likewise add that remarkable Analogy which there is between some Kinds of *Birds* and the *Animals* mentioned in the preceding Chapter, which lay themselves up, or sleep, during the Winter.

The *Birds* which have this Kind of Rest, and are lost to us, during the *Winter* Season, are *Swallows*, *Martens*, *Swifts*, *Cuckows*, *Nightingales*, and some others; and as the *Spring* Season is more or less temperate, so does it influence the waking of these *Birds* from the State of Rest, as it does also all *Animals* that sleep in Winter. The *Cuckow* and *Nightingale* commonly begin to sing about the first Week in *April*, and the *Swallows*, *Martens*, and *Swifts*, appear about that Time: Nor is Nature less bounteous to all its Off-spring, when it rouses these Creatures from their Lethargy. The *Vegetables*, which the Winter Frosts retrenched of their Beauties, are enlivened, and display their usual Ornaments, and become an agreeable Shelter and Habitation for those *Birds* which are re-instated in Life. This Temperature of Air equally puts the Juices of all the *Sleepers*, whether *Animals* or *Vegetables*, into Motion; and if such a Temperature of Air happens to reign for any Time before the natural Season, it has the same Effect upon their Bodies, and rouses them from their Lethargy. It was remarkable, that in 1719, we had no  
Frost

Frost or Snow of any Continuance in *England*, unless in the most Inland Parts. The Softness of the Weather in *January* and *February* was such as produced the Effect I mention, of waking these *Birds* before their Time. In *Lincolnshire*, and the adjacent Counties lying next the Sea, several *Cuckows* were seen and heard to sing in the first 15 Days of *February*; some Hives of *Bees* swarmed about the same time; and *Batts* were flying about, as they do commonly in Summer Evenings; but a cold Easterly Wind coming, soon afterward put them to Rest again. These *Birds*, which sleep in Winter, have certain Periods of Time in the Summer, when they are lost to us. About the Middle of *June*, *Nightingales* and *Cuckows* have finished their Song, and are seen no more till the following Spring. Indeed, as a Matter of Curiosity, I have known *Nightingales* kept in Cages for 2 or 3 Years together; and if they have been set in warm Places they have sung at *Christmas*. There is now a *Bird-Fancier*, in *Fetter-Lane*, in *Fleet-Street* who is never without them.

*Birds* differ from *four-footed* Beasts in the Manner of their Generation, and bringing forth of their Young: In these the *Female* has only one Cluster of Eggs; but we always find 2 *Ovaries* in every *Female* of the *four-footed* Race. In *Birds* and *Fowls* the *Egg* is made fecund by the *Male*, before it is excluded from the Body of the *Female*; and every *Egg* in the Body of the *Female* has a Power of Growth, to a certain Magnitude, before it can be discharged from  
the



the *Hen*, even tho' she has not been in Company with a *Cock*: For I have often seen *Birds* that have been kept in Cages lay *Eggs* in *April*, altho' they have not so much as seen a *Male* of their own kind; but these *Eggs* were not prolifick, altho' the *Hen* has set upon them above a Month. Among the Feather'd-Race, there is the same Possibility of Coupling between *two* of different Species, as there is between *four-footed* Beasts of different Kinds. It is common for *Cock Pheasants* to tread the *Hens* of common Poultry; but whether their *Eggs* are prolifick, and if they were, whether the *Chickens* were of a different Make, I know not.

The Covering or Clothing of *Birds* and *Fowls* must next be considered. They have growing upon them *Hair*, *Down*, *Feathers*, and *Quills*: The *Hair* is hardly to be distinguished but upon the larger Sort; and I think *Down* is only found upon what I call *Fowls*; for *Birds* and *Fowls* are in many things different from one another, *viz.* *Birds* always carry their Meat to their Young; *Fowls* lead their young ones to their Meat. All *Fowls* make their Nests upon the Ground; whereas on the other hand *Birds* build for the most part in *Trees*, *Hedges*, &c.

Every *Fowl*, whether of the Land or Water, has its Body cover'd with *Down*, either during a certain Space after it's hatch'd, or during its whole Life. The *Land Fowls*, such as common Poultry, *Partridges*, *Turkies*, *Pheasants*, and such like, only have this *Down* upon them till their

Feathers

Feathers appear. The *Water Fowls*, such as *Swans*, *Geese*, *Ducks*, *Widgeons*, *Teal*, &c. have always a Coat of *Down* under or beneath their *Feathers*.

The *Feathers* of *Birds* ought also to be carefully considered, how they vary in Make and Colour, with respect to the different Parts of Body which they grow upon; and this Variety seems to proceed from the Difference of the Juices in the several Parts they cover. All young *Birds* are clothed in *Feathers* of very different Colours from those they are dressed with when full grown; so that I suppose, in the first Stage of a *Bird's* Life, the Juices have not the same Powers in any part of the Body, that they possess in the second or last Stage. And it is likely that the *Hair* and *Wool* of *Quadrupedes* changes Colour as they grow older; for the same Reason, *Feathers* I suppose to have a kind of *Vegetable* Life; and I think it is not unlikely that they come from *Seeds*: They are all of them *Annual*, being renewed yearly; and therefore it is no wonder if Want of Nourishment, or over-abundant Heat of the *Bird's* Body, alter their Colours; which is no more than we meet with in common *Plants*, which often have the Colour of their *Leaves* and *Flowers* changed as the Nature of the Soil directs. An Instance of this was in some *Roots* of the *Double Blue Hepatica*, that were sent to Mr. *Harrison* of *Henly upon Thames*, from Mr. *Keys's* Garden in *Totbill-Fields*, *Westminster*, whose Soil was so different from  
the



the Ground they were planted in at *Henly*, that when they came to blossom there, they produced *White Flowers*, and therefore returned back to their first Station, where they retook the *Blue* Colour they had at first. And I have observed many other *Flowers* which have changed from the stronger Colours of *Blue*, *Red*, and *Yellow*, to a plain *White*, by altering the Soil.

Every distinct Species of *Birds* has to it self a certain Manner of feathering; yet it is possible to produce other Birds from them which shall differ in the Colour of their *Feathers*. I believe every Kind of *Bird* may have had one of its Race with *White Feathers*, which happens from the Want of Nourishment, or some ill Quality residing in the Juices that feed them, as was said before. I have heard that in King *Charles the II*d's Time there was a *White Crow* in *St. James's Park*. I have very often seen *White Sparrows*; and some time since I caught one of those *Birds*, commonly called a *Robin Red-Breast*, with all the *Feathers* from the Throat downward of a clear *White*, and every other *Feather* about him very different from the common *Feathers* of those *Birds*. In 1718 I was at the taking of one of the *Thrush* or *Black Bird* Kind, with *White Feathers*: This Change of *Feather*, from a strong Colour to *White*, is frequent among *Pheasants* and common *Poultry*; and where this happens, I find that the Coupling of one which is of the natural Colour, with one of the *White* Sort,

Sort, is the Cause that in the Breed or Increase some are Mottled, others *White*, and rarely any of the natural Colour, especially (as I observe) if the *Cock* was *White*. I think we may lay it down as a Maxim, that where-ever *Whiteness* is seen in the *Feathers* of *Fowls*, *Hair* of *Beasts*, and *Leaves* or *Flowers* of *Plants*, it proceeds from Weakness, or Want of Nourishment, in the Bodies they grow upon.

It is worthy our Observation, the Contrivance of *Birds* in the Building of their *Nests*; how every distinct Species hath a Method peculiar to it self in preparing its Lodging, not only as to the Curiosity of its Frame, but the Choice of certain Materials of which it is composed: And even its Situation is not less regarded by them. The Form of a *Marten's Nest* is wonderful, as well if we consider how every Part of *Clay* or *Mud* is brought in little Particles to make the Whole; as also the Position of those *Nests* under Shelter of some Pent-house, or horizontal Covering, to keep them from the Injuries of the Weather. As to the Form of the *Nest*, it is like a Cup pointed at the Bottom, with a small Hole or Notch towards the Brim, pointing to the East, to go in at, and the Inside is lined with *Feathers*, to make it easy for their Setting. The *Mag-pye* is likewise as careful to preserve its Young from the Injuries of the Weather and *Birds* of Prey as the *Marten*; but Nature has given him a different Kind of Cunning; his *Nest* is guarded on all Sides with *Thorns*, and lined with *Mud*,  
which



which he smooths beyond the Guess of any one that has not seen it.

The *Nests* of other *Birds* are every one as remarkable as these we have already mentioned. It is, I think, impossible any one can pass by the Works of these little Creatures without admiring the Delicacy of their Composition, and Beauty of their Contrivance; and particularly some of those *Birds Nests* which are so common in the *West Indies*, which are fastened to the Ends of tender *Twigs*, and hang upon Strings of about half a Yard in Length. By this Means the *Birds* and their *Eggs* are safe from destroying *Vermin*.

It is observable that the *Bills* of several Kinds of *Birds* are disposed in such Manner, that they can imitate an Human Voice; and their Memory of such Words or Tunes as have been often repeated to them is not a little surprising: It is frequent to find some Kinds of *Parrots* that will talk much, sing Songs, and express every Syllable with such Exactness, that many have been deceived by their Voice. *Jays*, *Starlings*, *Magpies*, *Bulfinches*, and the *Robin Red-Breast*, are often taught to pronounce Words distinctly: And there is now at *Chelsea*, near the *Ferry*, a *Raven* that speaks several Words plainly. Among these *Birds* which I have mentioned for speaking, we may farther observe the Tones of their Voices. The *Raven* has a Voice very deep and hoarse, as a Bass to the rest. *Parrots*, *Starlings*, and *Magpies*, come nearer the common Tone

of Mankind, as it were a Tenor to the former. The *Bulfinch* and *Robin Red-breast* speak in a Treble Tone or Pipe. One would think that the Mouths or Organs of Sound in four-footed Beasts were near enough resembling the Mouths of Men, to be made pronounce Words; but hitherto we have not found any *Quadrupede* that could be taught to speak; and when I consider this, I am surpris'd to find *Birds* (whose Beaks are so very different from the Figure or Frame of the Organs of Speech in Mankind) shou'd be taught to utter Words so distinctly as they do. As for the *Speaking Dog*, so much talk'd of, he utter'd several Words and Sounds; but they were not of himself, no more than an Instrument of Musick could produce Variety of Notes without the Help of an Artist to play upon it. The Master of this *Dog* having set him in a convenient Posture to get the full Management of his Throat and Chaps, made him growl, and moved his Chaps and Throat in that manner with his Hands, that some Words were plain enough pronounced to be understood; and I conceive it is no difficult Matter to bring any *Dog* to speak some Words, if we make use of the same Means: But *Birds* repeat Words distinctly without any Assistance of this kind.

The *Wings* of *Birds* answer to the Fore-feet of Beasts, so far as to make up the four Branches of the Body; and in the Motion of *Birds* upon the Ground, assist them to move forward with greater Swiftnes, as well as serve them for Flight.

The



The *Quills* and larger *Feathers* of the *Wings* are remarkably different from those on the Rest of their Body, and seem to bear the same Proportion with the other *Feathers*, that *Trees* do to *Plants* of an under Race. The other remarkable Parts of *Birds*, wherein they differ from *Quadrupedes*, are their *Beaks* or *Bills*, which are all of a Horny Substance, some long and pointed, as in the *Kingfisher*, *Woodcock*, *Snipe*, &c. others sharp and short, as in *Nightingales*, *Linnets*, and other *Birds* of piercing Note. Others again have clubbed *Bills*, as the *Bulfinch*, &c. some hooked *Bills*, as *Hawks*, *Owls*, *Parrots*, which give them a hollow Voice; and in most *Water Fowl* flat *Bills* seem to prevail, as in the *Swan*, *Goose*, *Duck*, &c. As the *Beaks* of them are various, so do their Notes or Voices all differ just in the same manner that *Quadrupedes* differ in the Tones of their Voices, by having their Mouths or Organs of Sound of various Makes.

The *Legs* of *Birds* are all of them covered with *Scales*; and as to the Number of *Claws*, I think they are generally the same, viz. 3 on each *Foot*, with a *Heel*: The *Ostrich* indeed has but 2; but these are all pointed with *Claws*, the which, as well as the *Scales*, are of different Make and Colour, as the *Fowls* or *Birds* they relate to are different in the other Particulars of their Bodies. But we may take notice likewise, that Nature was not unmindful of the Uses of these Parts, when they were first framed. To the *Birds* of Prey she has given *Talons*, for the better ta-

king and managing of their Food: And to such *Birds* as are inclinable to perch, she has been no less benevolent and careful in the Frame of their *Claws*; so likewise the *Fowls*, both of the Waters and the Land, are not unprovided of such Means, as only her own Wisdom could contrive the Model of, for their Swimming and Walking.

The *Tail Feathers* of *Birds* are disposed proportionably to each Kind, to assist in their respective Flights, chiefly by helping them to rise from the Ground, and serve as Rudders to guide their Bodies in the Air.

The Movement of *Birds* upon the Ground is of two Kinds. *Crows*, *Larks*, *Water-wag-tails*, and all the *Fowls* both of Land and Water, set one *Leg* before the other: *Sparrows*, *Goldfinches*, and the greatest Part of the *Bird* Kind, jump from Place to Place. All the *Birds* that have fallen under my Observation drink Water; but there are some four-footed Beasts that never drink, as the *Hare*, *Coney*, and some others. It is reported that the *Camel* will travel three Weeks without drinking.

The Food of *Birds* is of various Kinds, some preying upon *Birds*, others upon *Carrion*, others upon *Fish*; but the greatest Part upon *Fruit*, *Grain*, and *Insects*. The *Eagle*, and all of the *Hawk* Kind, with admirable Artifice take their Prey: And *Ravens*, as if their Smelling was the chief of their Senses, will follow *Carrion* many Miles: And the *Stork*, *Heron*, and all



all the *Water Fowls*, are indued with no less Sagacity and Contrivance in catching of *Fish*, which is their proper Food. *Sparrows*, and other *Birds* of the lower Class, flock together in Corn-Fields and Gardens, where the *Corn*, or other *Grain* or *Fruit* is fit for their eating: Others are no less vigilant and watchful to destroy *Caterpillars*, and such like *Insects*, where they are in any Plenty. From hence we may reasonably conjecture, that the Cause of *Birds* passing from one Country to another, is to meet with their proper Food. For in the same Climate or Country it is impossible to find a continued Store of *Insects* or *Grain*, all the Year, for them to feed upon.

The *Birds* of Passage are the *Woodcock*, *Quail*, *Wind-thrush*, *Fieldfare*, *Stork*, and some others; tho' the Season of their passing is different. The *Woodcock*, *Redwing*, and *Fieldfare*, make these Parts their Refuge in the Winter, and are rarely found here after the Frost is over; tho' I have been informed there have been *Nests* of young *Woodcocks* taken about *Tunbridge*; and I was once Eye-witness of a Brace of these *Birds* taken in their *Nest* about the Middle of *May*: But I suppose the Old ones had been wounded, and could not change their Station. About the Time these *Birds* commonly leave us, the *Quails* present themselves; and about the same Time in *Holland*, and some other Places in *Europe*, the *Storks* return to their *Nests*. Upon this Subject of the *Passing* of the *Stork*,

I have lately received the following curious Letter, which agrees perfectly with what I observed of that *Bird* when I was in *Holland*.

S I R,

**B**Eing lately in *Holland*, I enquired as much as I could of the People, concerning the Coming and Departure of those Storks, which I there saw in such great Numbers: The Account the People (especially at *Harlem*) gave me, was this: That the Storks having bred, and the Young flying about with them, at the End of September, or thereabouts, as the Heat of the Summer more or less continues, these Storks gather together (in the Peoples Opinion, almost to a Bird) about a great Piece of Marshy Ground, there called *Harlem Meer*. Being all assembled, they remain there several Days, chattering and snapping with their Bills, till the last Birds are come to them in this Place of their Rendezvous. After this they make no more Noise; but in a little time they all rise slowly together, soaring up in a great Flock and Body, making in the Air as they soar up several Rounds and Circles, till by Degrees this great Flock of Birds, which at its first Rise almost darkens the Air, goes gradually higher and higher, till at last they appear to be in a manner but a Point, and so disappear till the next Spring they visit them again. I am, &c.

The Eggs of Birds are as remarkably different from one another as the Birds themselves,  
and



and seem to keep a just Proportion with the *Birds* or *Fowls* that laid them. Their Spots and Variegations of several Colours are as worthy our Remark, as the *Feathering* of their Mother *Fowls*. The Number of *Eggs* laid by each Kind is for the most part constant: *Birds* especially seldom exceed 5 or 6 in Number, unless it be the *Tom Tit* and *Wren*, which sometimes lay about 12 a-piece; but *Fowls* commonly exceed that Number. It is remarkable, that if we take away the *Eggs* of *Fowls*, they will still continue to lay to the Number of 30 or 40 *Eggs*; so that they seem to have a discretional Power of stopping, when they have laid as many as they can set upon; or if they should happen to be spoiled by any Accident, they have a natural Freedom, whereby they can renew and make good their lost Clutch of *Eggs*. *Sparrows*, and other *Birds* which are familiar about Houses, will sometimes breed 3 Times in a Year; and *Pigeons*, if they are well fed, will breed 8 or 9 Times in a Year. The Time of Setting is about 3 Weeks for *Birds* and common *Poultry*; but *Turkeys*, *Pheasants*, and some others do not hatch under a Month. It is possible to hatch *Eggs* of all Kinds, without the *Hen* setting upon them. I have myself experienced the Hatching of *Chickens*, by an artificial Heat, agreeable to that of the *Hen's* Body.

Thus have I remarked what is most observable in the *feathered* Tribe; and that I may proceed gradually from these Creatures which

have the Power of Flight, to the Race of *Quadrupedes*, or four-footed Beasts, I am obliged to take Notice of the *Batt* or *Flutter-mouse*, and *Flying Squirrels*, which seem to be the natural Passage between *Birds* and *Beasts*.

Of the *Batt* or *Flutter-mouse* I have seen 3 Kinds, viz. the common Sort, frequent in *England*; one Sort about a 4th Part bigger than the common, with Ears twisted like *Rams* Horns, about an Inch and  $\frac{1}{2}$  in Measure; and a 3d Kind brought to us from the *West-Indies*, whose Body is as large as a *Rat*, and the Wings being extended, measure from Point to Point above 2 Feet. In these Creatures there is no remarkable Difference that I can remember, but the Size of their Parts.

These *Animals* partake of the four-footed Kinds in the Make of the Head, which agrees perfectly with those of the *Mouse* or *Rat* Kind; the Shape of the Trunk of their Bodies likewise is much the same, and are both covered with Hair. These *Animals* are also *Viviparous*, bringing forth their young ones exactly formed (like *Quadrupedes*) and giving them suck.

They partake of the *Bird* Kind in having only 2 Legs, beside the Hooks at the Points of their Wings; they have also the Power of Flying, and sleep like *Swallows* in the Winter. I have found many of these in old Walls, that have been quite void of Motion, and pressed together so close, that they hardly preserved their natural Figure; and yet these, as I was in-



informed, having been brought to a Fire, revived, and flew about the Room. The Note or Voice of these *Animals* is between the Chirping of *Birds* and the Cry of four-footed *Beasts*. These Creatures have not long Tails like *Quadrupedes*.

I have not yet met with a *Flying Squirrel* perfect enough to take a good Figure from; tho' there is one in the *Museum* of the Royal Society, which may satisfy us that there is such an *Animal*, and shew us that it has not only the necessary Parts for Flight, but partakes so much of the *Quadrupede*, as may now lead us to the Contemplation of four-footed *Beasts*.

*Explanation of the Plates relating to Chapters VII. and VIII.*

## P L A T E X.

Fig. I. *The Head and Legs of a Linnet; the 1st shewing the Manner of its Bill or Organs, designed by Nature for the Utterance of the most piercing Note: The 2d shews the Manner of its Legs and Claws disposed for Perching.*

Fig. II. *The Head and Legs of the Bullfinch, whose Beak is clubbed, disposed for the Utterance of more hollow Notes.*

Fig. III. *The Head and Legs of a Hawk, wherein we may observe how Nature has disposed them for the Catching of its Prey.*

## P L A T E XI.

Fig. I. *The Head and Legs of the Halcyon, or King's-fisher, which Parts are naturally disposed for Climbing and Catching its Food, which chiefly consists of Insects in the Bark of Trees, and Earth-worms.*

Fig. II. *The Head and Legs of the Woodcock, whose Bill is contrived for searching for his Food in the Ground, such as Earth-Worms, &c.*

Fig. III. *The Head and Legs of a Goose, which may serve to give us an Idea of the same Parts in most Kind of Water-Fowl.*

N. B. *These Plates were drawn from Mr. Dandridge's Cabinet in Moorfields.*

## P L A T E XII.

Fig. I. and II. *The Bird of Paradise in two Views ; taken from the Royal Society.*

Fig. III. *A Bird of Paradise from Amboyna, drawn from Dr. Ruysh's Cabinet at Amsterdam.*

## P L A T E XIII.

Fig. I. *The Back of the common Batt, shewing wherein it relates to the Bird-Kind, and what Affinity it has to Quadrupedes.*

Fig. II.



Fig. II. *The Fore-part of the same Batt; from Mr. Dandridge's Cabinet.*

## C H A P. IX.

Of QUADRUPEDES, or such ANIMALS of the Viviparous Race, as have FOUR Legs or Branches to their Bodies.

THE Tribe of *Animals* with 4 Feet are for the most part clothed with *Hair*; but some few only have a *Scaly* Covering, or else are clothed in *Spines*. The general Heads I shall range them under are, the *Talon-footed*, the *Claw-footed*, the *Hoof-footed*, and the *double Hoof* or *Cloven-footed*: And again, those of the *Horned Race* I distinguish by the Characters of the *Perennial horned*, and the *Annual horned Beasts*.

The *largest* of the *four-footed Race* is the *Elephant*, and I think there is none *smaller* than the *Mouse*. The Method of Motion in all this Tribe is horizontal, and to a few only is given the extraordinary Power of Climbing, by Means of their sharp *Talons*, or by the Frame or Texture of their Fore-feet, with which they can lay hold of the *Branches* of *Trees*, or whatever may be helpful to them for their Conveyance. The Walking of these Creatures is performed by moving the *Off-leg* before and *Near-leg* behind at one Time, and following that Motion with the *two* contrary *Legs*; but in their Running, they lift up at once their two  
Fore-

*Fore-Legs*, and in the next Motion follow them with their *Hind Legs*; so that the latter succeed the former in every Point of Ground, and in every Motion forwards of their Body. By this Method of Motion a good *Horse* will go 4 Miles in length in about 7 Minutes, which I believe is as much as any of the Race of *Quadrupedes* can do; but is not to compare with what is reported of the Flight of some *Birds*. If we believe the Accounts given us of the *Carrier Pigeon*, which we are told will fly 20 Miles in 15 Minutes, and may easily be tried; at that rate such a *Bird* flies 80 Miles an Hour, which, in a natural Day, *i. e.* 24 Hours, would amount to 1920 Miles; which continued Flight, during that Length of Time, I believe is in the Capacity of a *Bird* to perform; considering the Passage of some *Birds*, which when they leave us, may extend to 2000 Miles, if they go into *Tartary*, or some Part of *Africa*; for I do not find that they are ever observed in *Europe* when they have left this Country. And I am of Opinion, that few *Birds* can fly much longer than 24 Hours without resting, or at most 2 Days without eating: But we are sure that Animals of the four-footed Kind cannot even maintain the Height of their Swiftnefs a quarter of an Hour: So that it appears, *Birds* have a far greater Share of continued *Velocity*, than *Quadrupedes*; which is accounted for from the Lightnefs of their Bodies.

There



There are 5 sorts of *Hair* observable in the Cloathing of *Quadrupedes*, viz. the short *Hair* upon the *Hides* of *Horses*, *Asses*, and *Kine*; the long *Hair* in the *Manes* and *Tails* of *Horses*; the *Wool* of *Sheep*; the *Bristles* of *Hogs*; and the *Hairs* in the *Beards* of *Cats*, *Tygers*, &c. These have every one of them a kind of *Vegetative* Growth, and are renewed yearly, unless the Creature they grow upon is distempered. I suppose them to be of the Nature of *Bulbous-rooted Plants*, which when the *Leaves* of them decay, a new-framed *Root* from the same *Plant* supplies their Loss with fresh *Leaves* the next Season. In the *Hedgehog* the *Spines* or *Thorns* which cover its Body are *analogous* to the *Hairs* upon the *Skin* of other *Quadrupedes*; but I suppose may remain for many Years, whereas the others are *Annual*; and likewise I imagine the *Quills* of the *Porcupine* to fill the place of *Hairs* in other *Beasts*, tho, they are of a much harder Substance; and all these Coverings, as they proceed from the Bodies of different *Quadrupedes*, commonly vary in their Colours but are never so beautiful as the *Feathers* of *Birds*. Among *Beasts* we never observe any *Hairs* of a *Scarlet* Colour, nor is *Blue* or *Green* natural to them, and even *Yellow* is very sparingly given to this Tribe; while, on the other hand, *Birds* are adorned with *Feathers* of all Colours. Their Note, and Beauty of Plumage, attract the *Ear*, and cause in the *Eye* the greatest Admiration; but when we  
consider

consider them farther, they are but Toys in comparifon of *Quadrupedes*, which, tho' they are not thus gaily attired, are much more ferviceable to Mankind, and make amends for the Expence of keeping them.

The *Lyon*, *Panther*, *Tyger*, *Leopard*, and *Cats* of all Kinds, have fharp *Talons*, fomewhat refembling thofe in the *Eagle* and *Hawk* Kind; and for the better preferving them from wearing or blunting their Points, Nature has provided Cafes for them in the refpective *Paws* of thofe Creatures. What they call the *Claw-footed*, are *Dogs* of all Kinds, whole *Claws* are of a Substance fomewhat like the former, but are not guarded. *Hoofs* of *Horfes*, *Affes*, and *Mules* are *single*, and are not of fo hard a Substance as the former. The *double-hoofed* or *cloven-footed* Tribe have their *Feet* cased with Subftances of a *Horny* Nature; of which Clafs is the *Wild Boar*, *Stag*, *Fallow-Deer*, *Sheep*, *Goat*, and *Kine*. In one Kind indeed of the *Hog-Race*, which I have obferved at the late Earl of *Stamford's*, the *Hoofs* are not cloven or divided; but it is remarkable, that if a *Sow* of that Breed is coupled with a *Boar* of the *cloven-footed* Kind, fome of the *Pigs* will be *cloven-footed*, and others *single-hoofed*.

Of the *Horned Race*, the *Buck* is one of thofe Creatures which fheds his *Horns* every Year, and is but 3 Months renewing them again, which is a kind of *Vegetation* equal to the quickeft growing *Plant*. The *Stag* and fome other forts of *Deer* are



are subject to shedding and renewing their *Horns* annually, like the former ; and in the larger Kinds are sometimes of that Extent, that in a direct Line they measure from *Tip* to *Tip* above a Yard. They are so solid and hard when they are fully perfected, and of so large a Size, that it causes Admiration, how the Animal is supplied with Juices sufficient to extend them to such a Width in so short a Time. It is remarkable in the *Deer-Kind*, that the *Females* have no *Horns*; which I suppose is common with those Creatures, whose *Males* shed their *Horns* every Year.

The next kind of *Horned Animal* is the *Gazella*, or *Antelope*, whose *Horns* are erect, and twisting like a Screw ; these are not branched, nor do I find they ever shed. After these the *Goat* has his *Horns* twisted, and the Points bending towards his Back, but not both of them alike. The next is the *Sheep*, whose *Horns*, like the former, are twisted, and regularly curled. It is observable, that the *Horns* of these last Kinds are always larger in the *Males* than in the *Females*; but it is otherwise among Kine, whose *Horns* are smooth, and of large Extent; in these the *Females* have *Horns* much larger and longer than the *Males*, unless they have been castrated ; in such *Oxen* I have measured a Yard between the extrem Points of the *Horns*.

The Food of four-footed Beasts is either *Flesh* or *Fowl*, *Herb*, *Grain*, or *Fish*. Such as feed on *Flesh* are Beast of Prey, and of the most savage Kind, as *Lyons*, *Tygers*, &c. whose *Talons*

*lons* are chiefly designed for Catching and Tearing their Prey to Pieces. The *Otter* and *Beaver* feed chiefly upon *Fish*, which their *Amphibious* Nature and Structure of Parts enables them to catch. The *Hog* Kind eat indifferently of *Flesh*, *Fish*, *Fowl*, *Roots*, *Fruits*, *Herbs* and *Grain*. The *Deer* Kind, *Sheep*, *Goats*, *Kine*, *Horses*, and such generally as are of the *Hoofed* Race, feed upon *Grass*, *Hay*, or *Corn*. And it may be remarked, that such as use the latter kind of Diet are the tamest, and most familiar with Mankind; but such as feed on raw *Flesh* are of great Ferocity, unless familiarized when they are very young, and kept low in their Diet.

The *Qadrupedes* of Use and Service to Mankind are the *Elephant*, *Camel*, *Horse*, *Kine* of all Sorts, *Sheep*, *Dogs*, *Cats*, and some others. Where *Elephants* are naturally placed, they are of great Use after they are tamed, in transporting great Burdens, and carrying Men to Battle, where their Conduct and Strength is of extraordinary Service, if we may believe those Authors who have mentioned them. We have now one of them in *London*, who is so observant of the Orders of his Keeper, that we may reasonably place him amongst the most tameable of the four-footed *Animals*; and even allow him a Share of natural Sense, at least equal, if not superior, to any of his Race. He is 28 Months old, near 15 Hands high, and his *Tusks* (or rather *Horns*) are but beginning to appear, or bud



bud in the upper Jaw, which gives me Occasion to suppose them rather *Horns* than *Teeth*; and considering what vast Numbers of them are annually brought into *Europe*, I am almost persuaded they shed like the *Horns* of *Deer*. It is remarkable in this Creature, that the Joints of his *hind Legs* are disposed for Kneeling, as well as those in the *fore Legs*, which is contrary to other *Animals*. His Method of Drinking is by drawing his *Trunk* full of Liquor, and squirting it down his Throat. But we may see a large Description of one of these Creatures of a greater Age, and in more perfect State, with the Anatomy of him, in the *Phil. Trans.* N<sup>o</sup> 326, and 327, by Dr. Blair, F. R. S.

The *Camel* and *Dromedary* are *Beasts* of Burden, and very swift; and it is reported of them, that they will live many Days without Water, even in the hottest Climates. Some Creatures indeed I know will live without any Water at all, as the *Hare* and *Coney*, which I have kept above 3 Years, and they have never had any.

There are many Kinds of *Horses* remarkably distinguished for their different Uses. In *Northamptonshire*, and some of the *Midland Counties*, are such as are fit for the Coach, and drawing of other Carriages. In *Flanders*, *Denmark*, and some of the Northern Nations, we likewise find *Horses* of Draught, differing in their Frame and Turn of Body, and varying in their Degree of Strength, as the Countries they were bred up in differ from one another.

In *Yorkshire*, and some Places in *Wales*, are bred the best *Horses* for the Saddle. The first State of their Life being among the Mountains, enables them to endure hard Labour. Besides these, the *Spanish Horses* are counted the most famous for the Parade; and the *Turkish* and *Barb* Kinds for Beauty, are reckoned to exceed most *Horses* in the World.

Next to these, the *Kine* Race is accounted the most useful. In many Parts of *England*, *Oxen* are of great Service in Ploughing, drawing of Carriages, and for many other Works in Husbandry; besides the Service of their *Flesh*, after they are worn out by Labour, and the excellent Uses of their *Hides* and *Tallow*, and even their *Horns* for making necessary Utensils; while the *Cows* afford us *Milk*, *Cheese*, and *Butter*, not only sufficient for our own Use, but even to supply the Neighbouring Countries. Nor are *Sheep* less useful to Mankind, their *Annual* Produce of *Wool* serving to employ as many People as their *Flesh* can maintain in some Places of *England*. Their *Milk* is likewise made use of, and turns to good Account; to which we might add the Service of their *Skins*, which afford us *Leather*, *Parchment*, and *Vellum*.

Of the *Dog* Kind we have many different Sorts, such as *Grey-Hounds*, *Blood-Hounds*, *Beagles*, and others, for Hunting and taking of Game: And again, our *Spaniels*, either for Land or Water, *Setting-Dogs*, *Pointers*, &c. serve to find out Sport for their Masters; and some



Some of them are even useful for Draught and Carriage. In *Holland* and *Flanders* especially, they are commonly employed in the Harness, for drawing small Waggon and other Carriages. To these we may add such other Kinds of *Dogs* as are used for the Guard of Houses, among which the *English Bull-Dog* is the highest in Esteem, for his exceeding Fierceness and Courage.

The Voice of all these Creatures is as various as the Structure of their Mouths and Throats. We may discover each Kind of them by their Note or Tone, as well as distinguish one *Bird* from another by the Difference of their Song. The Parts which relate to this Kind of Speech among them, are like so many Instruments of Musick producing different Kinds of Tones. We might likewise mention how aptly all Kinds of *Dogs* are disposed to receive Instruction, and how observant they are to the Word of Command.

The *Apes* and *Monkeys* of several Kinds are naturally disposed to imitate the Actions of Men; but indeed the Figure and Disposition of their Parts agree much more with those in Mankind, than the Parts of any other Creature; and I believe some Sorts of them might be rendered useful, if convenient Care was taken to instruct them when young. One Sort indeed, which comes from the *East Indies*, is very vicious; and I remember has more than once attempted to force a Servant of the House where he was

kept: But I am informed that some of the larger Kinds have been so well instructed, that they would perform many little Offices that their Master directed them to do. It is no difficult Matter to be satisfied how much these Creatures are capable of Instruction, since there are so many of them daily brought to *England*. They are great Lovers of strong Liquors, and frequently are inebriated with them. They love *Tobacco*, and smoke abundantly if they can get it. Nor is the *Man-Tyger* less guilty of these Vices when he has Opportunity: His lower Parts are like those of a *Monkey*, but his Head is more like that of the *Hog*, and is a Creature very ready to imitate the Actions of Men. The *Females* of these have Periodical Visits, like *Females* of the Human Race. I conclude, that as the different Tone of Voices proceeds from the different Structures of the *Organs* of Sound in *Animals*, so the Difference of their Capacity and Understanding proceeds from the various Frames of those Parts which furnish the *Brain* with nourishing Juices.

All *Quadrupedes* generate by coupling one with another; but are differently impowered by Nature to increase more or less their several Species. Some of the larger Kind, such as the *Elephant*, *Horse*, *Kine*, and *Deer*, seldom bring more than 1 or 2 at a time; whereas the smaller Kinds of *Animals*, and such as are subject to be destroyed, increase more plentifully. The *Hog* Kind will sometimes bring 17 or 18 young ones  
at



at a Birth, and the *Dog* Race about 10; *Cats* and *Rabits* about 5 a-piece, *Rats* and *Mice* about 8 or 9 a-piece, *Squirrels* 3 or 4, *Hares* 2 or 3, and *Sheep* sometimes as many. And with regard to the Generation of these Creatures, the natural Time of coupling is in the Spring-Season, somewhat later than *Birds*; but by means of *forcing* Diet, some of them may be brought to couple even in the Depth of Winter; it is by that Means that we have *now* young *Lambs* at almost every Season of the Year; and some Creatures, as well in this as in the *Bird* Kind, couple and bring forth young ones 7 or 8 times a Year, as the *Rabit* for Example, and some others. We may also remark, that every *Quadrupede* has not the same Length of Time appointed for its Growth to its compleat State. The large Kinds, such as *Horses* and *Kine*, are hardly full Grown in 3 Years, *Hares* and *Rabits* about 8 Months, which perhaps may depend, in great measure, upon the Length of Time they are respectively maintained in the Womb of their *Dams*; but every Kind of *Bird* grows to its full Bigness in a few Months; and some Kinds of *Fowls* are about a Year accomplishnig their Growth; which Difference I suppose happens as the Difference of Time is appointed, more or less, for the Incubation and Hatching of their *Eggs*, some setting only 3 Weeks, and others a Month, before the young ones are excluded, or can make their Way thro' their *Egg-*

*shells.* And I believe the Length of Life allotted for several *Animals* is various, as the Time of their being included in the Bodies of their *Dams* is more or less. There are some of the larger Kind of Creatures which carry their young Ones many Months, as the *Mare*, *Cow*, and *Elephant*, as it is said, longer than any other Creature; but *Rabits* do not go above one Month, and *Cats* two: And I believe, was it possible to know the Nature of all Creatures, we might find, according to their Proportion and different Habit of Body, a continual Progression, with regard to their Stature, Growth and Length of Life. For in *Plants*, which I have been more conversant with, I observe that Kind of Progression; and it is to be remarked, that the several *Seeds* which they spring from, have as different Degrees of Time appointed for their coming up sprouting in the Earth; and likewise such as lie longest under Ground without shooting, are commonly more lasting than those which begin to shoot in a few Days; and we may observe something of the same Kind in *Insects*. The Distance of Time between the laying and the hatching of the *Eggs* laid by some sorts, is very different from what we observe in others; and the Time of Life in the *Caterpillar* of one Kind, is not the same that we observe in another, no more than the Number of Days is the same in all, for bringing the several *Flies* out of their *Crysalises*.

But it remains for me to say something more particular of the *Generation* of four-footed *Animals*, as it is the next relating, and in some  
Cases



Cases is nearly agreeing with that of Mankind. Were we to consider but the *Generation of Fowls, Fish, and Plants*, and even of some Creatures of the *four-footed Tribe* which are covered with *Scales*, it will appear that the *Eggs* of the *Females* are absolutely necessary for the Production of them ; and I suppose that the *fœcundating Liquor* or *Dust* of the *Male* is as necessary to make them prolific. In this Race of *Animals* every *Female* has its *Ovaries*, or *Egg-Nest*, which, without the Intromission of the prolific Juice of the *Male*, remains sterile or barren ; It therefore appears that the *Male Liquor* is necessary to impregnate the *Eggs* contained in those *Ovaries*, either by some *Animalcules* of it passing into the *Eggs* there contained ; or else that the *Animalcules* wound those *Eggs*, and so occasion them to grow over, and enclose them in such a manner, as the *Blisters* upon *Oaken Leaves* swell and inclose the little *Insects*, whose *Eggs* are laid in the wounded Parts by their Originals : But this Case has admitted of vast Dispute, either because some of the Disputants could not imagine how the *Animalcula* could get into the *Ovaries* ; or else that some suppose there is not Passage sufficient for the impregnated *Egg* to fall into the *Matrix* ; but these I suppose form their Judgments on the State of those *Parts* when the *Animal* is dead, which, in my Opinion, must then be very different from what they were when it was alive ; for then *these* as well as all *other* Parts of the Body have a Power of contracting or dilating themselves ; and a Passage, which at one time

is hardly capable of admitting the Point of a Pin, may probably be dilated so much as to give room for the Exclusion of a full-grown *Fœtus*; and certainly it would be very unreasonable to suppose *these Parts* are in the same Posture during Coition, that they are at another time; Nature then giving the Parts a different Action and Power of extending themselves. I could say more on this Head, if the Case had not already been so greatly perplexed; and I am loth to trust too far to my own Opinion, in an Affair of so much Difficulty. I shall therefore relate what has past by way of Letter concerning this Subject, between Dr. *Geoffroy*, of the Royal Academy, and Dr. *Andry* of *Paris*.

The former tells us, that such as support the *System* of Eggs in all Creatures, suppose the little *Animal* to be included in the *Egg*; but this they cannot demonstrate till Fœcundation: Also they suppose the little *Germ*s of *Plants* to be inclosed in the *Seeds*; but these Rudiments of the Plant in the *Seeds* cannot be discovered till after Impregnation, by the *Farina* issuing from the *Male* Parts. On the contrary, if we examine the *Eggs* of *Animals* before they have been rendered fœcund by the *Male*, we cannot observe the least Principle of the *Animal*. In the *Eggs* which the *Hens* lay without a *Cock*, although they appear fair, and as large as the others, yet nevertheless, we can only discern in them an empty *Cicatricula*, in which the little Body is not residing. Those who have had the Management of *Silk-Worms* may remark, that when



a *Moth* has laid its *Eggs* without the Assistance of the *Male*, those *Eggs* are transparent, and void of that little black Point which we discover in such *Eggs* as are fœcundated, and is the Beginning of the little *Worm* or *Caterpillar*; it is therefore we are not to expect any good from those transparent and barren *Eggs*. It happens sometimes that we meet with these transparent *Eggs* among those that are impregnated, even tho' they were all laid by the same *Moth*; which must proceed from some particular Cause in the coupling of the *Male* with the *Female*.

We may likewise observe the same Thing in the *Grains* and *Seeds* of *Plants*; we often meet with *Seeds* that are without the *Germ* or *Seed-bud*, and are consequently barren; and these are found even in the Middle of the fairest Fruits. If we observe likewise the *Seeds* of any *Plant* at the first opening of the *Flower*, we find them clear and transparent; but if we examine them some Time after the *Flower* is decayed, that is to say, after their Fœcundation, those *Seeds* become *Opaque*, by Means of a little Body inclosed, which is properly the *Germ* or *Seed-bud*.

The *Ovarists* suppose that these *Germs* were originally in the *Seeds*, and that they are now only grown bigger than they were at first; but this is a bare Supposition; for since we cannot discover this Point by the best *Microscopes*, either in *Eggs* or *Seeds*, before they have been fœcundated, and that it may be easily discovered after Conception, it is more natural to believe that those

*Germs*

*Germ*s were not subsisting in the *Eggs* or *Seeds* before they were impregnated, but from the very Instant of their Fœcundation. To convince you of what I advance, consider only what happens in the Time of Fœcundation among *Animals*.

Among those *Fish* which do not couple, the generative *Liquor* of the *Male* is only scattered upon the *Eggs* which have been laid by the *Female*, while they flit in the Water. In other *Animals*, where Things cannot be observed in the same Manner, we know only that the *Liquor* of the *Male* is conveyed into the Cavity of the *Matrix*, even as far as the *Tubes*, where it is often found in such *Animals* as have been opened a little while after Coition; and we may presume that it even passes into the *Ovaries*, and sprinkles some of the *Eggs* of the *Female*. It appears then, that Impregnation proceeds from an Effusion of the *Male Liquor* upon the *Egg*; from whence we may naturally conclude, that the Effect produced by this *Liquor* upon the *Eggs*, is chiefly to convey the little *Germ* or *Animalcule*, which is found in the *Egg* after that time; and the rather, because the *Animalcule* may always be observed in that fœcundating *Liquor*.

And we have yet more reason to believe that these *Animalcules*, which abound in the *Male Liquor*, are the Principles of Generation, or the Beginning of Man, and other *Animals*, as we find them always constant in the *Liquors* which are included in the *Spermatic Vessels* of every



every *Animal*, varying according to their different Species; but we sometimes find them wanting in those *Liquors*, either through extreme Age, or when Distempers have rendred them barren.

The System of the Generation of *Animals* being thus stated, we shall reason only upon constant Facts; whereas the *Ovarists* suppose that the Rudiments of the *Animal* are always in the *Egg*, altho' they cannot see them, and moreover, that there is a fœcundating Spirit in the Generative *Liquor* of the *Male*; but these are uncertain Suppositions; for according to them, this *Seminal* Spirit must be exceeding *Subtile* and *Volatile*: And nevertheless, among the *Aquatic Animals*, this Spirit, however *Volatile* it be, some say, it is neither enervated nor dissipated by the Waters with which this *Liquor* mixes itself; but this is altogether impossible. Some have been of Opinion, that the greatest Part of *Fish* do not couple, but the *Females* cast their *Eggs* or *Spawn*, and the *Males* which follow them scatter their *Milt* over the *Eggs*. Now before the Waters have extended this *Liquor* over all the *Spawn*, it must necessarily happen that the Fœcundating Spirit is dissipated. The Difficulty of Impregnation is still more considerable in *Oysters* and other *Shell-Fish*, which are fastened to Rocks, or the Bottom of the Sea, without having little or any Motion. The *Milt* of the *Males* is carried backwards and forwards at the Will of the Waters, and at last by Chance is brought to the *Eggs* of the *Females*,

*males*, and renders them fœcund. What will then become of this *Seminal Spirit*, when it is tossed about from Place to Place? If Generation was brought about by such Means, it would surely have Time enough to exhale, and then the *Eggs of Oysters*, and other such-like *Shell-Fish*, could not be impregnated by it.

But we shall avoid these two Suppositions in our System, and endeavour to produce more solid Arguments for the Generation of *Animals*, than the *Ovarists* have done. And first, let us examine if the Generation of *Plants*, does not carry along with it some Analogy to that in *Animals*.

Till the *Flower* begins to fade, we cannot perceive any *Body* or *Germ* of a *Plant* in the *Embryos* of the *Seeds*, or *Seminal Vessels*; nor can we discern any Change in those *Embryos* till the *Dust* of the *Stamina* is fallen.

This *Dust* of the *Stamina* is necessary for Fœcundation; for in all *Plants* where these *Stamina* appear, if we cut them off before they open, the *Fruits* will not come to Maturity; or if they should happen to ripen, they are without *Germs*, and are consequently barren.

The Necessity of this *Dust* of the *Stamina* for the Growth of the *Seeds*, for the bringing of them to Maturity, and for making them pregnant, is confirmed by the Observations of all *Botanists* upon the *Palm* or *Date-Tree*.

This Sort of *Plant* bears its *Stamina* upon a different *Tree* from that which bears the *Fruit*;  
so



so that one is stiled *Male*, and the other *Female*. *Theophrastus*, *Prosper Alpinus*, and all the *Botanists* agree, that if a *Female Tree* has not a *Male* in its Neighbourhood, it does not bring forth *Fruit*, or if it bears any, they rarely come to Maturity; they are ill tasted, and without *Kernels*, and consequently without *Germes*. But to bring this *Fruit* to Perfection, and make it fit to eat, Care is always taken either to plant a *Male Palm-Tree* in the Neighbourhood, or to cut *Branches* off the *Male Palm-Tree*, garnished with *Stamina*, and tie them to the *Branches* of the *Female Palm-Tree*, and then it produces good *Fruit*. This Observation was confirmed to Monsieur *Tournefort* in 1697, by *Hadgi Mustapha Aga*, a curious *Botanist*, Ambassador from *Tripoli* to the King of *France*.

There is one Objection which may be made against what we have mentioned concerning the *Palm-Trees*. Monsieur *Tournefort* tells us that he has seen a *Female Plant* of *Hops* produce *Seed* in the King's Garden, where there was not any *Male-Plant*. But we may suppose that the *Farina* or *Male Dust* was brought to the *Female Plant* by the Wind from some other Place; as in the Case mentioned by *Jovianus Pontanus*, Præceptor to *Alphonso* King of *Naples*, who tells us, that in his Time there were two *Palm-Trees*, one of them *Male*, cultivated at *Brindes*, and the other *Female*, growing in the Wood of *Ottiranto*; that this last was several Years without bearing any *Fruit*, till at length,

length, having out-grown and raised its Head above the other *Trees* of the Forest, it could perceive, says an eminent *Latin* Poet, the *Male Palm-Tree* at *Brindes*, altho' they were several Leagues asunder, for then it began to bear *Fruit* in abundance; and there is no Reason to doubt but it then begun to bear *Fruit*, because it then received the *Dust* of the *Stamina* upon its *Branches*, which was conveyed by the Wind from the *Male Palm*. We may explain by this, in a natural Manner, that *Fæcundity*, which so much embarrassed the antient Physicians, and which they attributed to a Sympathy, or Love among *Trees*. The Poetical Passage above-mentioned, being thus translated by my Friend Dr. Sewel, viz.

*A Female Palm for many Years had stood,  
The Virgin-Glory of Ottranto's Wood :  
No vernal Bloom with Flow'rs her Branches  
drest ;  
No Clusters her unfruitful Boughs deprest.  
Till distant far, in Brindes's fair Vale,  
Aspiring she beheld the noble Male  
Tho' distant, yet the genial Pow'r she feels ;  
Thro' ev'ry Vein the fertile Humour trills ;  
The pregnant Branches now their Blossoms  
yield,  
And ev'ry Bough with rip'ning Fruit is fill'd.*

It may be objected, that I have no sufficient Proof, that every Grain of this *Dust* is a *Plantula*



*tula* or *Germ*, since the *Microscope* shews us that each Grain is in the Form of a little *Globe* or *Egg*, either smooth, or set with Points, sometimes bored thro' the Middle, or of some other Form or Manner. I agree that it is difficult to distinguish in every one of these little Grains of *Dust* the Rudiment of a *Plant*, because it is wrapt up in itself, and perhaps may be covered with a *Membrane*, or at least clothed with some *Resinous* Matter; perhaps Time may discover some way of unfolding the little *Germ*, or freeing it of its Covering; but allowing this to be only a bare Supposition, we may agree that it is not altogether unreasonable, since it is not after the Intromission of these little Bodies into the *Pistillum* or *Uterus* of the *Flower*, that we can perceive any *Opacity* in the *Seminal Vessels* or *Embryos* of the *Seeds*, which in their Growth discovers to us that they are in effect the *Germes of Plants*.

In short, what confirms this *Hypothesis*, is its Uniformity with what we have discovered relating to the *Generation* of all living Bodies.

After having establish'd the Proofs of our *Hypothesis*, I am to answer the Objections which may be made against it.

*First*, It may be objected that an *Insect* cannot quit its Nature, as an *Insect*, to take upon it that of a *perfect Animal*,

It is an antient Error to make the Distinction of *Perfect* and *Imperfect Animals*. Our Eyes do  
not

not discover the same Parts that are in some Animals, in *Worms, Butterflies, Flies, Bees*, and other *Insects*; so that some thought such Parts were wanting. We see them take their Birth in *Mud, Dungbills, putrified Flesh, and Rotten Herbs*; which has made some believe that these little Bodies had no other Origin than a *fortuitous Assemblage of putrifying Parts of Matter*. They have even believed that larger *Animals*, such as *Frogs, Wild Ducks, &c.* had the like Beginning, without reflecting that those *Animals* were constantly the same in their Frame and Parts, which are always produced alike; and that it is impossible that Chance could produce an Arrangement of Parts always uniform and constant. We are obliged to the learned *Redi*, for having first set this Matter to rights by giving us Proof that the Generation of *Insects* comes from *Males and Females*, agreeable to the System of *Eggs*, as it is among all other *Animals*. Many learned Physicians, and particularly *Swammerdam*, have begun the *Anatomy of Insects*; and we are obliged to that great Man for having shewn us that those little *Animals* had Parts agreeable to ours, or at least did the same Functions; but as that Work was left unfinished, *Du Verney* has taken it up, and continues it with great Accuracy and Judgment, tracing those little Creatures from the Beginning to the End; and far from representing *Insects* as *Imperfect Animals*, he discovers so much Art and Contrivance in their Structure, that they seem to be even more *perfect* than the most considerable *Animals*. In

*Cater-*



*Caterpillars*, and such *Worms* as change into *Butterflies*, and in such *Reptiles* as take *Wing*, it is surprising to observe the Changes which happen throughout the interior Structure of their little Bodies. An infinite Number of Parts, which are folded up, explain and open themselves at the End of a certain Time; some become absolutely useless, dry up, and fall off; and others are alter'd beyond our Knowledge. Nothing can be more admirable than the Tracing of all these Changes. A *Frog* is a *Fish* in its Beginning, named *Tadpole*; it has a great Head, the Mouth of a *Fish*, the Fins and Tail like *Fishes*; it respire by the *Gills*, which are *Lungs* peculiar to *Fishes*: Some time afterward its Tail and Fins drop off, and its *Feet* appear, which are as well adapted to Walking as Swimming; the Fore-Part of its *Head*, or rather its *Mask*, falls off, with its *Gills*; in the mean while, the *Lungs*, which resemble those in *Terrestrial Animals*, unfold and dilate themselves, and become expanded and very visible, from almost invisible Parts that they were before. May not we look upon this as an extraordinary Perfection, and even more than Man himself can boast of, that Gift of Power in tasting Life successively in different States and in different Elements?

These Considerations may undeceive those who are prejudiced in their Opinions, that a Creature in the Rank of *Insects* cannot become a perfect *Animal*, especially if they reflect, that for the most part the State of *Worms* or *Caterpillars*

*lars* is only a State of Passage to bring them to another Form ; so that those *Worms* which are commonly ingendered in *putrified Flesh*, change into *Flies* ; likewise several great *Worms*, which remain some time under Ground, change into *Beetles* ; *Silk-Worms*, and *Caterpillars*, become *Moths* and *Butterflies* ; and I think the *Earth-Worm* is the only Species which does not suffer a *Metamorphosis*.

This being premised, we may regard the Form of the *Worm* or *Animalcule* in the Generative *Liquor* of *Animals*, as an Instance of the Certainty of future *Metamorphosis*.

It may be objected in the *second Place*, that I attribute an imaginary Instinct to the little *Animal* or *Animalcule*, to make it rise into its Cell. I confess the Difficulty of explaining so great a Mystery as that of *Generation*, without meeting a thousand Obstructions and Questions, which cannot be resolved without great Pains and Trouble ; but when an Effect is so evident that it meets with no formal Opposition, it does not seem reasonable to contest it : Such is the Difficulty in Dispute. Instinct in this Place is not the Question ; for I have not attributed it to the little *Animal* as a Means whereby it is conveyed into its Cell. I know too well, that in Physical Disputes we must make use of Mechanic Laws, and I shall endeavour to give such as are most probable.

The prodigious Multitude of *Animalcules* swimming in this Liquor, which disposes it self  
to



to overflow the *Egg* that is prepared to be impregnated, makes it almost impossible, that one of them at least should not reach the little Opening of the *Cicatricula*; and that from this prodigious Multitude there is not above *one* which can find place; for the *Cicatricula* is not capable of containing any more; but if by chance it is big enough to admit of *two*, we shall find two *Fætus*'s; under the same Covering, or else a monstrous double *Fætus* joined together by some Part of the Body. This is one Proof of the Authority of this System.

*Thirdly*, It may be said that we carry our Thoughts too far, in supposing these little *Animalcules* to be the Principles or first Points from whence Mankind is derived, and that they may have been appointed to swim in the *Seminal Liquor* for other Uses; as for Example: They may be supposed to agitate that *Liquor*, and to facilitate the *Exhalation* of the *Spirits*.

Besides what I have already observed of those who suppose a powerful *Spirit* in this *Liquor*, it seems much more natural to me to draw this Consequence (*i. e.*) That the *Animalcules* which are found in such vast Numbers floating in a *Liquor* so necessary for *Generation*, are themselves the immediate Cause of *Generation*, and not to believe that they are only remote Instruments of it; because we do not discover any nearer Cause. After this the Use which is assigned them is far from necessary, and there is no Likelihood that there is any Probability in it; for every Thing that is *Li-*

*quid* has in itself a motive Power, without having Occasion of such feeble Assistance, as that which it might receive from *Animals* moving in it; for is it reasonable to suppose that *Fish* were created in the Seas, or *Birds* were made to move in the Air, to prevent the Stagnation of those *Liquids*? The one is not more plausible than the *other*.

*Fourthly*, It is said that *Conception*, by Means of the *Animalcule*, is disagreeable to the System of the Unfolding of the Vessels and Parts. But wherein is this System of Unfolding more attacked in this *Hypothesis*, than in the common Sentiment of the *Eggs*? If we admit that *Adam* had in himself all the *Animalcules*, as it were, incased one within the other; do not also the *Ovarists* suppose in the same Manner, that all their *Eggs* were inclosed one in another, and contained in the Body of *Eve*? They cannot therefore make any Objections upon that Account, since we may as easily oppose their Opinion of the *Eggs*. But to defend both these Opinions against those who are too much embarrassed by the System of Unfolding of Parts, let them join with me, and consider how Nature acts in her Course, and they will see how the System of the Unfolding of Parts is incumbered; but at the same Time must agree to the Truth of it. But let us now examine what *Monsieur Dodart* says upon the *Fæcundity* or *Increase of Plants*, in his Memoirs, inserted in those of the *Royal Academy of Sciences*, for the  
Year



Year 1700. “ It is wonderful, (*says he*) that  
 “ the *Fæcundity* or *Increase of Plants* has been  
 “ so little observed by the World, especially  
 “ since they are so commonly exposed to the  
 “ Eyes of all People; not only the *Natural*  
 “ *Increase of Plants* of their own Accord, but  
 “ also their *Artificial Increase*, produced by  
 “ Cutting, or Amputation of their several  
 “ Parts.” This *Artificial Increase* he proves  
 to be no more than *Natural*; for, *as he justly*  
*observes*, “ All the Art of a Gardener cannot  
 “ give to *Plants* what they had not in them-  
 “ selves; his Skill only assists them to unfold  
 “ and explain those Parts which they were ori-  
 “ ginally possessed of. Here follows an Exam-  
 “ ple of the Increase and Multiplication of a  
 “ *Tree* by the *Seed* only, which is the last Term  
 “ and Object of all the Productions of a *Tree*.  
 “ The *Branches* of the *Elm*, are so many  
 “ *Branches* of *Seeds* or *Grains* extremely pressed  
 “ one against the other; and having taken an  
 “ *Elm* of 6 Inches Diameter, and 20 Feet  
 “ high in *Stem*, which was about 12 Years  
 “ old, I cut off a *Branch* of 8 Feet long; and  
 “ neglecting the *Seeds* which had been shaken  
 “ off by the repeated Blows of the Axe, and  
 “ the Fall of the *Branch*, I yet found on it  
 “ 16,450 *Seeds*.

“ We may suppose that an *Elm* of 6 Inches  
 “ Diameter must carry more than 10 *Branches*  
 “ 8 Feet long; but suppose 10 only, then  
 “ these 10 *Branches* may reasonably produce,

“ according to the above Account, 164,500  
“ *Seeds*. All the *Branches* which are less than  
“ 8 Feet long, taken together, make a Sur-  
“ face more than double the Surface of the 10  
“ *Branches* of 8 Feet; but supposing them on-  
“ ly double, because perhaps these lesser *Bran-*  
“ *ches* are not so prolific as the others, then all  
“ the *Branches* together produce 329,000 *Seeds*.

“ An *Elm* may be supposed to live 100  
“ Years; and it is not reasonable to suppose  
“ that the mean State of its Fertility should  
“ be at the Age of 12 Years; we may then  
“ justly reckon, that in an indifferent bearing  
“ Year, it will produce 329,000, or may well  
“ enough suppose 330,000 *Seeds*, which are  
“ little enough. Again, we must multiply this  
“ 330,000 by the 100 Years Life of the *Elm*,  
“ which makes 33,000,000 of *Seeds*, which an  
“ *Elm* produces in its whole Life-time, taking  
“ every Thing at the lowest Rate, and these  
“ 33,000,000 came all from one single *Seed*.

“ But this is only the natural Production of  
“ the *Tree*, which hath not yet produced all  
“ that it contains.

“ If the *Tree* had been headed, it would  
“ have sprouted afresh from the Trunk, and  
“ at least produced as many *Branches* as it had  
“ before in its natural State; and these new  
“ Shoots would not require more than the  
“ Space of 6 Lines, or thereabouts, in Height  
“ of the Extremity of the headed Trunk to  
“ shoot from.

“ At



“ At whatever Place, or whatever Height  
 “ the *Tree* had been headed, it would have al-  
 “ way re-germinated with equal Vigour; which  
 “ is constant, as appears by the Example of  
 “ *Dwarf-Trees*, which are continually kept  
 “ cut almost down to the Ground.

“ From hence we learn, that all the Trunk  
 “ of a *Tree*, from the Earth, to the first Ger-  
 “ minating of the collateral *Branches*, is filled  
 “ with *Principles* or little *Embryo's* of *Bran-*  
 “ *ches*, which cannot possibly appear all at the  
 “ same Time; we conceive them to be parted  
 “ by little circular Rings of 6 Lines in Height,  
 “ each of which in particular is ready to pro-  
 “ duce *Branches* as soon as an Amputation is  
 “ made exactly above it.

“ All these invisible *Branches* (altho' they  
 “ are hidden) are no less existing than those  
 “ which appear to us; and if they were once  
 “ manifest, they would produce an equal Num-  
 “ ber of *Seeds*, which consequently they must  
 “ already contain in little.

“ Now were we to follow the Example pro-  
 “ posed, there is included in this *Elm*, as many  
 “ Times 33,000,000 of *Seeds* as there are  
 “ Spaces, that is to say, 15,840,000,000 of  
 “ *Seeds*; and that this *Tree* contains actually  
 “ in itself wherewithal to multiply and re-  
 “ produce such a prodigious Quantity of *Plants*  
 “ as would surpass all intelligible Numbers.”

What will those say to these Observations,  
 who are afraid of over-burdening the System of

unfolding Parts? Will they not be forced to acknowledge, that their Ideas are too narrow for the infinite Foresight of the Creator in the Propagation of *Living Beings*? But it is permitted at present, that our Reason even penetrates beyond its own Power, where the Senses have carried us; and where they begin to abandon us, they will plainly discover, that whatever their Senses have shewn them, is nothing in Comparison of that which may hereafter be found out; for if we only suppose that each Grain of a *Tree* contains in itself a 2d *Tree*, which again incloses the same Number of *Seeds*; and that we can never discover a Grain which contains more *Trees*, nor a *Tree* which contains more or fewer *Seeds* than the preceding *Tree*; then consequently there is a Geometrical Progression of Growth, whose 1st Term is one; the 2d 15,840,000,000; the 3d the Square of 15,840,000,000; the 4th its Cube; and so on, *ad infinitum*; so that our Reason and Imagination would in some Sort be lost, and swallowed up in the immense Calculation.

This prodigious Chain of Numbers strikes Terror in the Spirits of those who are not used to push their Meditations to any great Length; but those who are used to the Study of Physic and Mathematics, know very well that they cannot go far without meeting some Kind of Infinity, as if the Author of Nature had been careful that his principal Character should reside in every Thing.

If



If then we agree with the System of unfolding of Parts in *Plants*, which I think there is no Reason to doubt of, we may as easily admit the same in *Animals*, and it will be so much the more demonstrable, as this System is the most simple of all others; for if it be acknowledged, that *God* created all Things at *one Instant*, we need not torment ourselves to find out how *Organized Bodies* may form themselves, which is no more than the unfolding and explaining of their Parts one after another; whereas, on the contrary, it will always be found as difficult to explain their *Fortuitous-Formation*, as it will be to demonstrate that *Gold, Silver, Copper, Steel, and Enamel*, being put into a Crucible, the Parts of each Matter would dispose themselves in so regular a Manner, as to form a Clock or Watch.

*Fifthly*, It is objected, that the *Animalcule* which begins to discover it self in the *Egg*, after *Conception*, is not a *Worm*. To this I answer, that if we could open the *Cicatricula* of the *Egg* immediately after *Conception*, (that is to say, as soon as the *Worm* is entred into that Part) we might discover that little *Animal* yet under the Form of a *Worm*; but as it begins to grow bigger almost as soon as it receives a new Nourishment in the *Egg*, and as new Parts begin at the same time to unfold themselves in it, it is not strange to find it then alter from the Form of a *Worm*; and we may observe the different States of its Passage from that Form, to that of the *Animal* which is to be produced.

With

With regard to the Observations of the *Fœtus*, whether it be formed in the *Ovaria*, or in other Parts of the *Matrix* a very little while after *Conception*, those Observations do not destroy my *Hypothesis*: All that can be said is, that the little *Animalcules*, which are the Principles of Mankind, lose the Figure of *Worms* a little after they are entred the *Eggs*, and begin to take upon them the human Form: And as to the Observation of our learned Critic, that Nature gives the most *perfect Animals* a longer Time of Ripening, or coming to their last State, altho' it is not a General Rule, yet nevertheless it happens to be true enough in Mankind.

Among the Observations of the *Fœtus* inserted in the *French Transactions* for 1701, *M. Dodart* has given us One of the most remarkable, of an *Embryo* of 21 Days; it was then but 7 Lines in Length, and it was difficult to distinguish its Parts; the *Head* and the *Trunk* of the Body only could be discerned; the *Thighs* and *Arms* were not yet unfolded; and the *Head* was one 3d of the whole Length. Can we then say that this *Embryo* had the perfect Figure of Mankind, or was entirely formed? and was it not in this State more like to a *Worm*, which it was originally, than to the Form of a Man? For we may suppose that the *Head* of the little *Worm* was become the *Head* of the *Fœtus*, and that the rest of the Body had been hidden in that Part, which made the *Tail* of the same *Worm*: But here I may say that the *Worm* is not yet perfectly of the



the Form of Mankind (to speak like our Author) at the End of 9 Months, when he should come into the World ; for we may say that he is not in his perfect State till he is 21 Years old, which is about the Time when an human Body has acquired all its Proportions ; which agrees with the Account of our Critic, who will not be surprized, that a *Worm* may be changed into a *perfect Man* in so long a Space of Time.

*Sixthly*, In the next Place some attack the *System of Plants*, and object that the Disposition of certain *Pistils*, which lengthen themselves beyond the *Apices*, cannot therefore admit of or receive the prolific *Dust*.

I agree that some *Pistils* are much longer than the *Apices*, and have their *Orifices* a good Distance beyond them ; but this only happens in reversed *Flowers*, such as the *Crown Imperial*, &c. where this Situation of the *Pistillum* favours Fœcundation ; for in such *Flowers* the *Dust* cannot fall from the *Capsules* of the *Apices*, without falling upon the *Pistils*, which, in some Subjects, are garnished with little *Hairs*, the better to retain the prolific *Dust* ; besides, most of them are indued with *Glutinous* or *Viscous* Matter. In the *Tulip*, and some other *Flowers*, the *Pistillum* does not begin to raise itself above the *Apices*, till they are full ripe, and have scattered their *Dust*.

I agree that it is not sufficient to prove only that the prolific *Dust* of the *Apices* may fall upon the *Pistils* of the *Flowers* ; we must conduct

duct it even into the very *Cells* of the *Seeds*: And I own that it is very difficult to comprehend how this *Dust* can get there; but because we find a Difficulty in any thing, are we therefore to conclude it is impossible? and especially when we may observe so much Preparation as we see in *Plants*, towards the perfecting of the prolific *Dust* in the *Apices*; as also how it is scattered when it is full ripe, at a certain time, when the *Pistils* are ready to receive it: May we not remark as much Difficulty in the *Generation* of *Animals*? When we find that the Entrance of the *Infundibulum*, or *Vagina*, of the *Matrix* in *Birds* is very distant from the *Ovaries*, one can hardly imagine how the *Eggs*, when they detatch themselves from the *Ovaries*, seek out the Overtures of the *Vagina*, although there is no doubt but they do. So all the Garniture of *Flowers* may perswade us of the Necessity of the prolific *Dust* for impregnating the *Seeds*; and the Proofs which I have already given may convince us of it. A few Observations, which Time may produce, will set this Matter in a clearer Light.

*Seventhly*, I am told that the *Blossoms* of an *Abricot-Tree*, which were robbed of the *Apices* by *Vermin*, produced good *Fruit*. But are they assured that all the *Apices* were intirely eaten, or whether they were destroyed before they had scattered away some of their *Dust*?

*Eighthly*, We are not to suppose that the Wind



Wind can be an Intermittent in this Kind of Fœcundation.

But is it more difficult to suppose that the Air is an Intermittent in the Fœcundation of *Plants*, than to make the Element of Water an Intermittent in the Propagation of *Fish*, and chiefly of *Oysters* and other *Animals*, which lie *immoveable* at the Bottom of the Sea?

*Ninthly*, Some add, that if the little *Grains* of the prolific *Dust* were so many *Plants*, they would produce as many *Plants* as there were *Grains* falling upon the Earth. And why then don't they raise the same Difficulty in the *Liquor* designed for the Propagation of *Animals*? For, in short, if the little *Animal* or *Animalcula* does not meet with a convenient Nourishment in the Earth or Water to make it grow, and can only find what is necessary for its Support in the *Egg* of the *Female*; neither can the little *Germ* of the *Plant* meet with a proper Nourishment in the Earth to unfold its Parts, but only finds it in the *Embryo* of the *Seed*.

If my Reader will examine impartially the several Opinions upon the Generation of *Plants* and *Animals*, and weigh well the Proofs of one and the other, and observe the Difficulties which are to be met with in all these *Hypotheses*, I doubt not but he will agree with ours, as it is the most general, and has less Suppositions than the others; and after all, I desire him to observe that I lay this down only as an *Hypothesis*,  
in

in which appears more Probability of Truth than any I have yet seen upon this Subject.

There are *two* Things yet remarkable in *Generation* after the *Eggs* are impregnated. In some *Animals* the *Eggs* are excluded from the Body of the *Females*, to be afterwards incubated and set upon, till the Creature is so far perfected as to break its way thro' the *Shell*, as in the Case of *Birds* and *Fowls*, which are therefore called *Oviparous*: But the Case of *Quadrupedes* is different; the *Fætus* is not excluded from their Bodies, till it has taken that Form or Figure which it maintains to the End of its Life: Such *Animals* are termed *Viviparous*. One might make yet several remarkable Distinctions among those created Bodies which are *Oviparous*. The *Eggs* of *Birds* hatch at once into Bodies properly formed, agreeing with the Figures of their own Race. The *Spawn* or *Eggs* of *Frogs* have several different Changes before they gain their compleat Figure. The *Eggs* of *Butterflies* and *Moths* hatch at first into *Caterpillars*, and from this Shape change into a *Chrysalis*, and from that again into the Fly. The *Seed* or *Eggs* of *Plants* hatch at once into a *Plant*; tho', indeed, we may observe in some of them a considerable Difference between the *Seed-leaves*, and those which they are adorned with when they shoot out their *Stalks* and *Branches*: The *Ear-leaves*, or those next the *Root*, as I have already hinted, doing the same Office to the *Virgin Plant*, as the



the *Breasts* or *Dugs* of the Mother *Animals* do their Young, *i. e.* to furnish them with their first Nourishment, and support them till they can find a suitable Food in the Earth: And this is so certain, that if we take away the *Ear-leaves* of a *Plant*, soon after it has made its first Shoot from the *Seed*, the *Plant* will die in a short Time. The *Eggs* or *Spawn* of *Fish* hatch and become *Fish* at once; but in some of this Race (I am told) the *Eggs* or *Spawn* are not impregnated till after they are excluded from the Bodies of the *Females*.

It is observed by some great Men, that the *Animalcules* in the *Seminal Liquor* will live several Days after the Death of their *Male Parent*; and even some have gone so far, as to affirm, that these *Animalcules* will remain alive in the *Matrix* of the *Female* 2 or 3 Months after the *Liquor* has been lodged there, altho' they had not the Advantage of the proper *Nidus* or *Egg-nest* to afford them any Help; and then conclude, that those Parts may be impregnated by such *Animalcules* 2 or 3 Months after Copulation, which (as they say) is the Reason that some *Females* are longer between the Time of Coupling with the *Male*, and bringing forth their Young, than others; so that, according to their System, some of the human Race may bring forth 11 or 12 Months after they have been with a *Male*.

To confirm the System of *Generation* by the *Animalcules* in the *Male Liquor*, we may observe,

serve, that in such *Animals* as are not yet arrived at their highest Perfection, the *Male Liquor* in them is wanting of *Animalcules*. If we examine the *Testicles* of small *Chicken*, or any young *Bird* or *Fowl*, soon after hatching, or any *Animal* newly brought into the World, the *Male Liquor* has not any *Animalcules* in it, no more than can be found in the *Seminal Vessels* of an extreme old Man, or any Creature that has been worn by Distempers; but we never fail to find them in vast Numbers in such Bodies as are full grown, and in a vigorous State of Health. But I shall conclude this Account of *Generation*, with observing only, that the *Egg* of the *Female*, before Impregnation, seems to possess a Degree of Growth or Life, somewhat like that in *Minerals*; when the same *Egg* is impregnated, it then possesses a Kind of *Vegetative Growth*; and takes upon it the *Animal Life* and Growth as soon as it quickens, at which Time it only begins to enjoy the Power of *Sensation*.

We come now to observe such of the four-footed Race as are *Amphibious*, or live as well upon the Land as in the Waters: Such is the *Hippopotamus*, or *River-Horse*, which is found about the River *Nile*, which Creature is as big as a large *Bull*. There is now one of them well preserved at the Physic Garden at *Leyden*. After this the *Otter* and *Beaver* may be observed, as *Animals* which inhabit Pools, Ponds,



Ponds, and Rivers of little Resort, whose Prey is chiefly upon *Fish*. And next these the *Seal* or *Sea-Calf* may well enough be placed, as it much more relates to *Quadrupedes* than the *Fish* Kind: It is *Viviparous*, and thinly clothed with *Hair*, and likewise suckles its Young; but its *Tail* and *Fin-like Feet* declare it to inhabit the Waters, for the most Part, being rather contriv'd for swimming than for walking or moving upon the Land.

Having now considered the principal Parts of *Quadrupedes*, and given some Account of their Uses, we are next, in order, led to treat of such four-legged Creatures, as are partly *Animal*, and partly *Insectal*, such as *Frogs*, *Toads*, &c.

*Explanation of the Plates relating to Chap. IX.*

## P L A T E XIV.

Fig. I. *The Head and Legs of a Cat, setting forth the Disposition of those Parts in most Beasts of Prey.*

Fig. II. *The Head and Legs of a Mouse, shewing the Difference between the Claw-footed and the Talon-footed Beasts; as also the Disposition of the Joints to help them in their Motion.*

Fig. III. *The Head and Legs of a Horse, in which we may observe the Strength and Manner of its Jointing, and the whole Hoofs of a*  
M Horny

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Horny Substance, disposed as well for its De-  
fence as for hard Labour.*

P L A T E   X V .

Fig. I. *The Man-Tiger ; from Africa.*

Fig. II. *A Monkey of an extraordinary  
Kind ; from Mr. Randal's Collection, in Chan-  
nel-Row, Westminster.*

Fig. III. *The Head and Legs of a Spaniel,  
being a Continuation of the Claw-footed Kind.*

P L A T E   X V I .

Fig. I. *The Head and Legs of a Hog, being  
one of those Cloven-footed Animals, without  
Horns.*

Fig. II. *The Head and Legs of a Buck, or  
a Cloven-footed Animal, of the Annual Horned  
Race.*

Fig. III. *The Head and Legs of a Stag, or  
the largest Kind of the Cloven-footed Annual  
Horned Race.*

P L A T E   X V I I .

Fig. I. *The Elephant, brought from Fort  
St. George in the East-Indies, whose Tusks are  
not yet cut or budded. As the Tusks of this  
Creature always grow in the Upper-Jaw, I  
suppose them rather Horns than Teeth.*

Fig. II.



Fig. II. *The Head and Legs of a Goat, or one of that Race with irregular twisted Horns, which are Perennial.*

Fig. III. *The Head and Legs of a Sheep, being one of the Race which produces curled or twisted Horns.*

Fig. IV. *The Head and Legs of a Bull, serving as an Example of the smooth Horned Tribe, whose Horns are Perennial.*

## CHAP. X.

*Of Frogs, Toads, and such Creatures as are partly Animal, and partly Insectal.*

THESE Creatures are in some Respects like the *Animals* treated of in the preceding Pages, and in other Things are *analogous* to *Insects*: They agree with the former in the Number of their *Legs*, and the Method of their Coupling; only that in these the *Males* and *Female* are joined for 3 Days, and the *Quadrupedes* already mentioned, are not so long in that Act. Their fleshy Parts are like those in *Animals* of the four-footed Kind; but the many different Changes they have between the *Spawn* and the *perfect Frog*, is as remarkable as those in the *Insect* Race. Again, the *Frogs* sleep, or are laid up in the Winter, as are the longer-lived *Insects*: And their different Degrees of Life, within and without the Waters, make them somewhat

*analogous* to *Gnats*, which live their first Stage of Life in the Waters, and the Remainder of their Time in another Element.

The Difference between *Frogs* and *Toads* in *England* is very remarkable, tho' some will hardly allow any, which I suppose proceeds from their Want of Observation. They will have it, that *Toads* are no more than *Male Frogs*, or that all *Frogs*, which have black Backs, are those which we ought to call *Toads*; but I hope to set them right in the following Accounts of both.

The *Skin* of our *English Frogs* is smooth, their Motion nimble and agile: One Sort has the *Skin* on the *Back* of a dark Colour, and the other is yellow, marked with Specks here and there. The *Skin* of the *Toad* is rough and knotted, and its Motion is heavy, dull, and crawling. The *hind Feet* of the *Frog* are webbed like those of a *Goose*; and *Frog Spawn* are as large as *Pease*, and is brought forth in a Lump. The *Feet* of the *Toad* are not webbed, and its *Spawn* is small, and chained together. *Toads* will live in damp shady Places, without ever entring the Waters; but *Frogs* cannot live out of Water. The Voice of the *Toad* is much coarser than that of the *Frog*, and its Method of Life in many Things different. A *Toad* will live a long while in the Air-Pump, after the Air is exhausted; but a *Frog* will die in less than half the Time. We have Instances of *Toads* that have been  
found



found in small Cavities in the Middle of large Blocks of hard Stone. And I was once Eye-witness of a *Toad* which was sawed out of the Center or Heart of the Trunk of a large *Oak*; but I have never yet heard of any *Frog* that was thus inclosed. It is reported, that an angry *Toad* will piss a Sort of venomous Liquor, which is injurious to any living Creature it touches, but especially to Mankind. I had once one of them, which spouted some of this *Liquor* in my Eye, but I received no Damage from it; perhaps, because I immediately washed it with fair Water at a Pump; but we do not find that *Frogs* ever produce a *Liquor* of this Kind. It is common in *France*, and is now introduced among us, to eat the hinder *Legs* of *Frogs* as a great Dainty; but I have not yet heard of any that have been bold enough among the *Europeans* to feed upon *Toads*, unless some Mountebanks, who have done it to shew the Excellency of their Antidotes. I have often heard, that the People of *China* sell *Toads* in the Markets, of a very large Size, and hold them to be great Dainties; but I suppose they are rather *Frogs* than *Toads*, and have only been thought to be of the latter Kind, for Want of Knowledge enough of the material Differences which we find in one and the other. Upon the *Alps* there is a Kind of *Toad* about four Times larger than our *English Toad*. And I have seen in the Cabinets of Mr. *Seba*, and Dr. *Ruysb*

*A Philosophical Account of the*  
of *Amsterdam*, many Kinds of them well preserved, and great Variety of *Frogs* with long *Tails*, curled *Ears*, and their *Backs* marked with various Figures. In the *first* of these Cabinets there is a remarkable Set of *Frogs*; which, from the Form of the common *Frog*, differ in the Frame of their Parts gradually, till the last is of the Figure of a *Fish*. I shall now account for their *Generation*, and of their gradual Alterations from the *Spawn*, till they become *perfect Frogs*, as it was observed by that accurate Anatomist, Dr. *Douglas*, F.R.S. to whom I am likewise obliged for the following Relation.

*Of the curious Structure and Constitution of the Genital Parts in a Female Frog, full of Eggs.*

Of all the constituent Parts of this Animal, there are none more artfully contrived, nor so curiously framed, as those that serve for propagating the *Species* in both Sexes, but especially in the *Female*; and from the great Analogy and Likeness that is between *these*, and those in *Women*, we may draw a most convincing Argument to strengthen and inforce their Opinion, who maintain the System of the *Eggs*.

2 *Ovaria*, 2 *Oviductus's*, and 2 *Uterus's*, are the Parts to be described.

The *Ovaria* are two large vesicular Bags, formed of a thick glandulous *Membrane*, with  
a Cavity



a *Cavity* within very apparent, if you distend them with Wind.

Each *Ovarium* is placed about the Middle of the *Abdomen*, laterally on each Side the *Spine*, being fastened by *Blood-Vessels* and *fibrous Connexions* to the *Mesentery*, upon the upper Part of each *Kidney*.

Their Bigness varies according to the Number and Magnitude of the *Eggs* they contain; for just after they have dropt off, they look flaccid, being contracted into a narrow Compass, feel soft and slimy, and appear of a yellowish Colour, having a Number of little black Specks or Points here and there intermixed; but when the *Eggs* are come to their Maturity and full Ripeness, they are very large, and look of a *black* Colour spotted with *white*, very much distending the *Belly*.

The *Tubes* or *Oviducts* are two long *Channels* or *Pipes*, lying on the Sides of the *Belly*, between the *Lungs* and the *Uteri*. In their natural Situation they are rolled up and fastened together by a *Membrane*, as by a *Mesentery*, making several anfractuous *Gyri*, or winding Circumvolutions, not unlike the small Guts in little *Birds*.

These, as well as the *Ovaria*, differ in Bigness and Colour, according to the Seasons of the Year, and different Times of Gestation; for just after all the *Ovula* are passed, they are slender, and very small, of a yellowish Colour: However, if they be thrown into

the Water, they swell and become something bigger : But just before the *Ovula* are loosened, they are as big as a *Goose-quill*, of a whitish Colour ; and if they are then thrown into Water, they will, in the Space of *one Night*, swell six times bigger, and in a little time after they will dissolve into a kind of Mucilage or Jelly. The Inside of these *Tubes* are covered with a thick, slimy, glutinous Matter, which besmears the *Ovula* in their Passage, and afterwards serves for a *Nidus*, if not for Nourishment also, to the little *Animals* or *Tadpoles*, all whose perfect *Lineaments* are wrapped up and contained in these *Ovula*, as it were in Miniature ; so that when all that ropy, viscid Gluten, separated there by the *Glands*, is rubbed off, they must needs lessen in their Bulk.

The Beginning of each *Tube* is upon the *Septum Transversum*, just under the *Lobes* of the *Lungs* near the Heart ; it opens by a pretty large *Orifice*, and its Substance, for about half an Inch, is membranous, with some *Striæ* or *Ridges*, appearing upon it.

The *Uterus* is made up of a very thin and transparent *Membrane*, being divided into 2 distinct *Cavities* by a *Septum*, and each of them opens by a particular *Orifice* into the *Rectum Intestinum*, which passing over this *Bag*, braces it down, and makes it bulge out on each Side.

When the *Ovula* are come to their full Maturity, they are detached from the *Ovarium*,  
and



and being loosened, they fall into the *Cavity* of the *Abdomen*, where they float about for some Time, till by the Motion of the *Sterum* and abdominal *Muscles*, being much assisted by the constant and long Compression of the *Male Frog*, (which, according to the Observation of the curious *Swammerdam*, rides upon the Back of the *Female* 40 Days, closely embracing, and clasping round its Body with His *Fore-legs* under Hers, joining His *Claws* upon the *Sternum*) being received into Her gaping *Orifice*, the same Motion does forward its Progression to the *Uterus*; and it is not improbable, but the *Tube* itself may have something of a *Vermicular Motion*, which may be of use in propelling the same. After they have been some time in the *Uterus*, they are discharged, *statis temporibus per Annum*, the *Male* being ready, at that very Instant, to besprinkle them with his *Semen*, in order to impregnate and render them fruitful.

We find in the common *Female Frog*, that the *Ovaries* spread themselves almost over her whole Back, and even reach within a very little of the *Head*; which I believe is common to all the *Frog* kind, altho' they do not always produce their Young after the same Manner. The curious *Surinam Frog*, which Madam *Mariana* of *Amsterdam* has published in her *History of Surinam Insects*, brings its young ones perfectly framed into the World, after they are hatched in certain Cells, within the *Skin* of the *Back*. Sir *Hans Sloan* has one of these Creatures in his Cabinet;

Cabinet; and we may find more of the same in the Collections of Mr. *Vincent* at *Harlem*, Dr. *Ruysh* and Mr. *Seba* of *Amsterdam*, and at the Physic Garden in that City, in which Cabinets of Rarities I have observed this *Frog* in 3 different States; 1st, the *Pores* of the *Back Skin* were all closed, excepting 3 or 4, which began to be forced open by the *Eggs* lodged in Cells below them: The 2d had all the *Pores* in the *Skin* of the *Back* so much opened, that I could plainly discern the Points of the *Eggs* within them; and the 3d had young ones in the Figure of the *XXIId Plate*. I chuse rather to rank it with *Frogs*, as it is Web-footed, and an Inhabitant of the Waters, than place it with the *Toad Race*.

From what we have here said, it appears that *Frogs* and *Toads* partake of many Qualities observable in *Insects*, tho' not in every Respect; but as they agree with them in some Particulars, I shall next consider those *Insectal Bodies*, which may be stiled irregular *Insects*.

*Explanation of the Figures relating to Chap. X.*

## P A L T E XX. A.

*In this Figure I. A the Parts of Generation in an English Female-Frog are delineated, being first taken out of the Body, and then expanded. A:A: The Tuba Uterina or Oviduct separated from its Connections, and drawn out to its full Length.*

I. Its



1. *Its upper Orifice.*
2. *Its Opening into the Uterus.*
3. *Some of the Ovula sticking in its Cavity.*
4. *Part of the membranous Mesentery left on.*
5. *The Circumvolutions and Windings of the Tube.*
- C. *The empty Ovarium.*
- D. *The Uterus distended with Eggs or Spawn, appearing of a blackish Colour at the Sides, but whiter in the Middle.*
- E. *The Intestinum Rectum cut open, and turned back on the Sides of the Uteri.*
6. *The small Orifice or Opening, by which the Ovula pass from the Uterus, tempore partus.*
7. *The Spinster Ani.*
8. *The Levator of the same.*
9. *The Vesica Urinaria divided and laid back.*

P L A T E XX. B.

*In this Plate are represented, in 17 Figures, drawn from the Life, the slow and gradual Epigenesis Ranarum ; that is, all the remarkable Changes, and the several Gradations that are observed in the Growth of a Frog, from the Ovum, or Spawn, to a compleat and perfect Animal.*

No. 1. *Exhibits an Ovum just spawned, and taken out from the Heap, or as it appears when*  
it

*it drops from the Uterus in a Cluster, having a round black Speck, or Punctum nigricans, in the Middle, which is the first Rudiments of the Tadpole: The Outside of this Spot is of a whitish Colour.*

No. 2. *Shews the Ovum, after it has lain some Days in Water, surrounded with its Gluten, or a viscid, glewy Substance, commonly called Sperma Ranarum, or Frogs Spawn.*

No. 3. *Here the black Speck has changed its Round Figure into an Oval One, being curved, and smaller at one End than the other.*

No. 4. *In this, the Gyrinus, or little Animal, is grown bigger, and the Pellicula, or thin Membrane, that contains the viscid Substance, appears ragged and tore, as if Cobwebs hung to it.*

No. 5. *The glutinous Humour, that in the preceding Figure was smooth and even, appears in this to be hollow, like a stoned Raisin.*

No. 6. *Shews the Gyrinus (which now has put on the Shape of a Vermiculus, or little Worm, called properly a Tadpole, and by our Country People a Bull-head) sticking by its Mouth to the glutinous, alimentary Substance. After the Vermiculus had undergone this Change, I first observed it to move its Tail, and become a living Animal.*

No. 7. *Here we have exhibited the little Tadpole detached and freed from the viscid Matter, that not only served for its Nourishment, being received in at its Mouth, for it*  
had



*had nothing analogous to the Vasa Umbilicalia, to convey it that way, but also for a Bed to lie on while weak and tender: Here are likewise observable, a Head, Body and Tail, with two little sharp Points near its Head.*

No. 8. *Represents our Gyrinus much bigger, with a thicker Head and Body, and a long narrow Tail; and being touched, was able to move itself in the Water very nimble and quick, like a small Eel; and from this frequent whirling round in the Water, this little Creature is named as above.*

No. 9. *In this Tadpole, you may perceive some of the Windings and Circumvolutions of the Guts, through the thin transparent Skin, and other Integuments of the Belly.*

No. 10. *By this Figure, the same Animal is represented in a different View, in which it appears to be less than the former.*

No. 11. *Here we may with Pleasure observe the two hinder Legs sensibly budding out: The Tail which, like a Rudder, serves to steer or move its little Body, is very large; the Sides or Edges of it are thin and transparent; and down its Middle there runs a thickish hard Substance of a brownish Colour.*

No. 12. *In this View, we see the hind Feet longer, one of the Fore-legs half out, and the other just beginning to protuberate through the Skin.*

No. 13.

No. 13, 14, 15. *Do all represent the Tadpole, gradually grown bigger.*

No. 16. *Here the Gyrinus, or Tadpole, is now undergoing its last Change; and as soon as the Tail, which is now almost wore off to a Stump, is quite lost, it assumes the Denomination of a perfect Frog, which*

No. 17. *Representeth to our Eye.*

## P L A T E XXI.

Fig. I. *The Frog fully perfected.*

Fig. II. *The common English Toad.*

## P L A T E XXII.

Fig. I. *The Surinam Frog, shewing the Manner of its bringing its young ones, perfectly formed, out of the Pores, in the Skin of its Back.*

## C H A P. XI.

*Of SNAILS, EARTH-WORMS, CENTIPEDES, MILLEPEDES, SPIDERS, and Insects without Wings, which may be stiled irregular Insects.*

**T**H E S E *Insects* have very surprising Particulars, differing almost in every Thing from all other created Bodies. The *Snails*, which I shall first treat of, have indeed  
some



some little Affinity to *Animals*, such as the hatching of their young ones at once perfectly formed. They are *Oviparous*, but the Manner of their Coupling is extraordinary: Every single *Snail* possesses the *generative Parts* of both Sexes, and makes use of them equally when they couple: The Situation of these Parts is on the left side of the Head; but are only to be discovered when they are *generating*, which is about the Middle of *May*. They remain in Copulation about 12 Hours, and are then hardly to be separated without wounding their Parts. About 3 Weeks after this Act is over, they make their way into the Earth, and lay their *Eggs* in Knots of about 30 in Number, near 4 Inches deep; for this they commonly make choice of a moist, shady Place, in which Station their *Eggs* are hatched in about a Month, and young *Snails* then appear above Ground. The Manner of their meeting to couple is well worth observing; in *dewy* Evenings, or after a Shower of Rain, they crawl upon the Grass in a circular manner, making several Rounds, till they come near enough to one another to accomplish their Design; I have observed them sometimes make above 20 Turns before they could join. The *Dew Snails*, and what Gardeners call *Slugs*, have all of them the same Mode of *Generating* as we observe in the *Shell Snail*, which is of several Kinds with regard to the Consistency of their Flesh, and the Colour and Variegation of their Shells; but upon their first hatching they are so very tender, that the Weight of a few Grains would crush them

them out of Form ; and it is hard at that time to make any Distinction between the different Kinds. Their Flesh is of a Spungy Texture, and the Juices which afford it Nourishment are viscous ; which I suppose may be one Reason why the Motion of *Snails* is so very slow, that Kind of Juice being of too thick a Substance to circulate quickly. I have been informed, that the most Intense Cold, which can be produced, either by Nature or Art, cannot freeze the Juice of *Snails* ; but I think all *viscous* Matter is hard to be congealed ; for I do not find that *Bird-lime*, if it is in any considerable Body, will freeze, if it be exposed to the coldest Air, no more than the *Berries* of the *Mistletoe* or *Viscum*, whose Season of Ripeness is in the coldest Time of the Winter ; but other *Seeds*, whose Juices are more *aqueous*, are spoilt by a little Frost. The Food of all this Race is tender *Leaves*, and young *Sprouts of Plants*, which they devour, by means of a Tooth-like Body growing in their upper Jaw, with which they rather scrape the *Leaves* to pieces than macerate them ; for there is no Sign of any Teeth in their lower Jaw. In the XXIII<sup>d</sup> Plate I have given a Figure of the *Teeth*, but especially of the generative Parts, as they appear at the Time of their Coupling ; both done with a *Microscope*.

The better to discover the Degree of Life in these Creatures, whose Circulation of Juices seems slow enough to come nearer to a State of Stagnation



Stagnation, than the Motion of Juices in other Animals, I have endeavored to find out the Situation of the Heart, and to compare its Motion with the *Beats* of a *Pendulum*. The first Subject I met with, which gave me the View of this Part, was a small *Snail* just hatched, whose *Body* and *Shell* were so transparent, that I could discern its *Beats* to be distant about 3 Seconds; but as I supposed the Juices in this were much more fluid than in the older *Snails*, I had recourse to some of the largest I could find; but their *Shells* not being transparent, I was obliged to take them off as well as I could, without wounding the *Snails*, and then on their left Sides I plainly discovered the *Beats* of the Heart to be about 5 Seconds distant from one another, and 3 Hours afterwards about 7 Seconds, tho' some of them were then strong enough to begin the renewing of their *Shells*, which they effect, by flinging out a large Quantity of *viscous* Matter thro' the Pores of that Part of the Body which had been incased before. The Motion of these Creatures is performed by repeated Undulations of their fleshy Parts, without the Help of any *Feet* that I can discover; this undulating Motion presses a *viscous* Matter out of their Pores, which serves to fasten them to any thing they crawl upon, and helps them in their creeping up the Sides of *Walls* or *Trees*, and even when they reverse their Bodies, and creep upon *Cielings* with their *Shell* downwards. But it is observable, that a *Snail* seldom has any Motion but when it is in search of Food, or is about Generating, and then it is

N

only

only when the Ground is wet, and it has Opportunity of supplying its lost Juices by fresh Food. I have remarked, that when a *Snail* is obliged to pass over a dry dusty Place, it loses so much of its *viscous* Juice, that it can hardly recover it again.

I now proceed to the *Earth-Worm*, whose Shape is long and round, and their Bodies composed of several *Annuli*, jointed in one another, upon some of which, some curious Men have observed little *Feet* or *Asperities*, with which it is supposed they take hold of the Ground as they creep along. This *reptile* Motion, as Dr. *Tyson* observes, may be explained by Wire wound on a *Cylinder*, which when split off, and one End extended and held fast, will bring the other nearer it. In this manner the *Earth-Worm* having shot out or extended its Body, (by a sort of wreathing) it takes hold of the Ground with its small *Feet*, and so contracts the hinder Part of its Body. These Creatures cannot bear Heat any more than the *Snails*, and seldom are seen out of the Earth but when they are disturbed, or when a Dewy Evening or wet Weather invites them to couple; and even then they do not entirely quit their Holes, but extend their Bodies as far as they conveniently can to reach one another, and couple much after the same manner as *Snails*, *i. e.* by performing each of them the *Male* and *Female* Duty. But I have not yet been nice enough in this Enquiry, to determine whether they are *Oviparous* or *Viviparous*.

I shall next take notice of *Jointed-Worms* with many *Feet*, which are called *Centipedes* and



and *Millepedes*: These have always their Habitation in shady moist Places, chiefly in rotten Wood, and under Logs, or amongst Rubbish. Our *English* Kinds of *Centipedes* are about 2 Inches long, consisting of about 30 *Joints*, every one of which has 2 *Legs*, as small as *Hairs*, so that they have in all about 60 *Legs*, which they move alternately; and yet for all this mighty Number are but slow in their Motion, compared with other *Insects*. In the *West Indies* there is a kind of *Centipes* about 8 Inches long, when it is full grown, whose Figure I have taken from the Royal Society's Collection; but how these Creatures are produced, I have not yet had an Opportunity of observing, any more than the Generation of those Creatures called *Millepedes* or *Wood-lice*, which, tho' they bear that Name, have not above half the Number of *Legs* that we observe in the former. Their Bodies are covered with *Jointed Scaly* Substances, which give them something of the Figure of an *Armadillo*; but I never observe the Parts of these to alter as those do among the regular *Insects*, which I shall treat of in the next Chapter.

I come now to mention the *Spiders*, another Tribe of *Insects* which is very numerous, there being above 140 different Kinds of them in *England* only, as the curious Mr. *Dandridge* of *Moorfields* has observed and delineated. It is observable in this Race, that they are all wanting of that Part which we might properly call the *Head*. As the Bodies

of regular *Insects* are commonly divided into 3 Parts; the *Head*, the *Stomach*, and the *Tail*; these, for the most part, have their Bodies divided only into 2, resembling as it were the Bodies of *Bees* or *Wasps* without their *Heads*; but about the Place where the *Head* should be set upon the Bodies of *Bees* or *Wasps*, i. e. the Passage immediately into the *Stomach*, we observe 2 *Feelers* or *Antennæ*, with Tooth-like *Jaws*, for the pinching and macerating their Food. Upon the Upper Side of the same Part we discover their Eyes, which are commonly 8 in Number, and differently placed, as the *Spiders* are of different Make. The *Long Legs*, which is of this Tribe, has its Body undivided, and no Sign of any *Head* any more than the rest. Mr. *Dandridge* observes, that this Kind has but 2 *Eyes*; and I have not remarked that it is fond of Motion, but remains constantly in the same Place where it is hatched, unless it be provoked or disturbed. It is remarkable that all our *English Spiders* have 8 *Legs*; but those which come from the *West Indies* have 10. Among *Spiders* we may farther observe, that as they are of different Classes, they have different Modes of Motion, and of catching their Prey; one of the smaller sort jumps from Place to Place; another Kind, after running about a Yard, makes a full stop, and then running about the same Length stops again; others are so very quick and continued in their Motion, that they will run about 10 Yards in 2 Seconds. Again, we may remark, that such Kinds as have *Webs*, have different Manners of composing



composing them; some of them are of the Figure of a Tunnel-Net, disposed for catching all kind of *Flies* that come into it, the *Spider* himself lying out of Sight: These Kinds are commonly found in Houses, and are more voracious than any of the other Kinds. Another Sort makes his *Web* almost of the Figure of a Casting-Net, and places himself always in the Center. The Regularity and artful Contrivance in its composing this *Web*, together with its surprising Manner of passing from *Bough* to *Bough*, without any Help but the Air, to lay its *Foundation Threads*, is well worth our while to observe, and perhaps may have given some Assistance to the Inventors of Weaving or Knitting.

We have many Accounts of the Flight or Sailing of *Spiders* in the Air, by Means of their *Webs* or *Thread*; but I have not yet had an Opportunity of observing it. I have measured the *Webs* of some of the larger Kind of *Spiders* in *England*, in one of which there was above 48 Yards of *Thread*; another contain'd about 46. It appears by Mr. *Dandridge's* Collection that we have but 9 different Classes of *English Spiders*; one of each Class is in the 24th Plate, wherein I have also given a Cut of the *Tarantula*, taken from that in the *Royal Society*, which *Spider* is said to be venomous, and has given Rise to many Relations, which I account fabulous; but there is no Creature of this Race which I esteem more extraordinary than the large *West-Indian Spider*, which measures sometimes above

N 3 5 Inches

5 Inches over, as may be seen in Dr. Ruysb's Cabinet at *Amsterdam*. It has 10 *Legs*, covered with long brown *Hair*, which gives it a very frightful Aspect. It is said that the *Web* of this *Spider* is strong enough to catch the *Humming Birds*, which it preys upon.

Among these *Insects*, I cannot help mentioning the *Ant* or *Pismire*, whose Industry and Cunning may afford us sufficient Matter for Observation. It is one of those *Insects* which either sleeps the Winter, or is laid up at that Time; but I rather believe the latter, because of its Care in providing and hoarding Food. There are several Sorts of *Ants*, some of which are larger than our common House *Flies*; these are called *Horse-Ants*, and are seldom fewer than 5 or 6000 together: Their Habitation is commonly under the *Roots* of great *Trees*, where they may best live undisturbed. They feed commonly upon dead *Insects*, or *Carrion*, like the common small Kind, and seem to agree with them in every respect but their Size. If we open one of their *Nests*, we discover Galleries and Passages in several Ranges one above another; but yet all so disposed, as to have a free Communication one with another. It is observable among these Creatures, that if any of their own *Brood* happen to be killed, they immediately remove him from their Habitation; and if they meet with any dead *Insect*, or other proper Food in the Course of their Travels, they find means to bring it home, altho' it be very distant from their Apartments. There is no  
better



better Way to prepare the *Skeletons* of *Mice*, and other small *Animals*, than by fixing those Creatures in a right Posture in a little Box with Holes in it, and burying it among these *Ants*, which, in a few Days, will clear the Bones of all the Flesh; so that they are able to perform what the finest Knife in the World can scarcely execute. This Sort of *Ant*, as well as the smallest Kind, is hatched from an *Egg* about *June* or *July*. I have observed, that by Sun-Rising, the whole Colony is employed in bringing up their *Eggs* to the Surface of their Hill, that they may be within the Reach of the Sun's Warmth; but as soon as the Sun begins to decline, they renew their Labour, and return their *Eggs* to the lowest Caverns, to lie safe from the Evening Cold; and this they do every Day when the Weather will permit, till their young ones are hatched. Some among them have *Wings*, and those leave the rest in a few Days to seek some other Habitation. It is remarkable, that the common small *Ant* will often frequent Houses in search of their Food; and if they are lucky enough to find out Sugar or Sweet-meats, their whole Tribe are soon apprized of it, and follow them to the Place. A noble Lord gave me a remarkable Instance of it: A *Nest* of these Creatures in his Garden discovered a Closet of Confections many Yards within the House, and had a constant Recourse to it, by a certain Road which they traced out through two Rooms, which they observed so exactly, that they hardly varied an Inch from it; and what is most remarkable, these Creatures

continued for some Days the same Route, notwithstanding the sweeping and cleaning of the Rooms they past thro', till the whole *Nest* was destroyed.

I have observed one Sort of *Ant* which lays its *Egg* in the Back of the *Oak Leaf*, and raises the Blisters in those *Leaves*, which we call the *Oak Berries*. Those *Berries* are round, and about the Bigness and Consistency of a half grown *Grape*: In every one of these is a single *Insect* perfectly formed; so that it appears it has no Change after hatching.

I shall conclude with the *Ear-wig*, which we have not yet remarked to have any Change of Figure after it is once hatched; but only when it is full grown, we may discover its *Wings* folded up in small Cases upon the Middle of its Body, as may be observed at Mr. *Dandridge's*. I shall proceed to consider those *Insects* which we may call *regular*, such as the *Papilionaceous*, *Bee*, and *Fly* Kinds.

*Explanation of the Plates relating to Chap. XI.*

## PLATE XXIII.

Fig. I. *A Land Snail in a creeping Posture.*

Fig. II, *The Teeth of the same Snail in the Upper-Jaw, done with a Microscope.*

Fig. III. *The Male and Female Parts of Generation in the same Snail. A: The Orifice of the Female Part. B: The Tube of the Male Part.*



Part. C: *The Glans of the same.* D: *A wire-like Substance proceeding from the same; done with the Microscope.*

Fig. IV. *A Snail divested of its Shell, whereby we may discover the Situation of the Heart at A.*

P L A T E XXIV.

Fig. I. *A Garden Spider.*

Fig. II. *The Long Legs.*

Fig. III. *An Hedge Spider.*

Fig. IV. *A Garden Spider.*

Fig. V. *The Jumper or Tick Spider.*

Fig. VI. *The black House Spider, whose Antennæ are seemingly pointed with Diamonds.*

Fig. VII. *The Velvet Long-Legged Spider, taken under the Eaves of a House at Newington.*

Fig. VIII. *A black Hedge Spider.*

Fig. IX. *A striped Hedge Spider.*

N. B. These are the 9 Classes of *English-Spiders* collected by Mr. *Dandridge*.

Fig. X. *The Tarantula, or poisonous Spanish-Spider; from the Royal Society's Collection.*

## C H A P. XII. and XIII.

*Of the Papilionaceous or Butterfly Kind ; and of Bees, Flies, and some Others observed with the Microscope.*

**A**MONG the several Species of *Insects*, we do not find any that possess a greater Share of Beauty in the Colours of their Clothing, nor a more exact Symmetry in the Arrangement of their Parts, than *These*. To this we may add the surprising Changes of these Creatures, between the Time they are in the *Egg*, and their taking *Wing*. Those of the *Butterfly* Kind are most commonly marked with the gayest Colours ; and the *Moths*, which are regularly marked and variegated, have an agreeable Disposition of the graver Colours : But however these are *grave*, or the others *gay* in the Colours they are adorned with, there is so just a Harmony between one Colour and the other, that we can never say the Grave is *dull*, nor the Gay too *glaring*. Both the *Butterfly* and the *Moth* have their *Wings* adorned with *Feathers*, as regularly disposed as those in the *Wings* of *Birds*, though they are hardly to be discerned without the Assistance of *Microscopes*, and is that which is erroneously called the *Dust* of their *Wings*. The Bodies of the first are divided into 3 Parts ; the *Head*, joined by a tender *Filament* to the *Center*, or *middle Part* of the Body, and that again is more strongly



strongly joined to the *Tail*, which consists of many *Annuli*. The Bodies of the *Butterflies* are long and thin; but those of the *Moth* Kind are thick and short. All of the first Race have long slender *Antennæ* knotted at the Points; but the *Moths* have their *Antennæ* short and feathered. And we may again make this Distinction between these *Two*, that the *Butterflies* always fly in the Heat of the Day, and the *Moths* after the Sun is down. I am the rather thus full in the Particulars of these Creatures, when they are in the *Winged* State, because it is necessary to speak of the Manner of their *Generating* before I treat of their *Eggs*. The Life of these Creatures, in this State of Perfection, is much *longer* in the *Butterfly* than in the *Moth* Kind. I have known *Butterflies* live 3 Weeks; but I have never observed the *Moth* to live so long. The Manner of their *Generating* is equally performed by Coupling; but Mr. *Dandridge* makes this Remark on the Method of *Coupling* in *Insects*, that the *Female* always enters the Body of the *Male*, contrary to all Creatures of other Kinds, which he says is the same with the common *Fly*, that we may more easily observe it. Immediately after the Coupling of these Creatures, they lay their *Eggs*, and are so observant (if they are at Liberty) of the Place they lay them upon, that we may be assured it is proper for their Hatching, and convenient for their feeding, when they are in the *Caterpillar*. If we examine their  
*Eggs*

*Eggs* with a *Microscope*, we shall find some of them *transparent*, and others *opaque*: The *transparent Eggs* are *sterile* or *barren*; but the others will hatch at their proper Seasons, if the Weather be agreeable to them. In the Case of *Silk-Worms*, it is held by some *Romish* Superstitions, convenient to carry the *Eggs* to Church, upon the Festival of a certain Saint, by the Mistress of the Family, who carefully wraps them up in a Cloth, and lays them in her Bosom, till she has performed some particular Duty; but it is the Warmth of her Bosom which has so much Influence over the *Eggs*, that they hatch at her Return Home.

The *Eggs* of all the *Papilionaceous* Tribe have different Length of Time to hatch in, as their Originals are different in other Respects. Some will only lie a few Days, others 2 or 3 Weeks, and others 6 or 8 Months, without hatching: And again, the *Caterpillars* or *Nymphæ* of these Creatures have different Periods of Time allotted them for growing to their full Proportion; and their Forms, in their *Nymphal* State, are every one respectively agreeable to their several Tribes, and have some of them in that State the Appearance of 8 and 10 *Legs* apiece, altho' they never exceed 6 in Number when they come to have *Wings*. They are frequently variegated with beautiful Colours, and often surprisngly clothed with *Hair*; and yet it is not to be observed, that either the *Hair* or *Colours* they possess, while they are in this State,



State, is any way agreeable to what we find in them when they have got *Wings*: Nor indeed can we expect to find them strictly the same, because, while they are laid up in the *Chrysalis*, every Part of the preceding *Caterpillar* seems to be reduced to a State of Confusion, much more than we can imagine it was even in the *Egg* or unhatch'd State. All these, during the Time they are in the *Nymphæ*, feed upon the *Leaves* or *Flowers* of *Plants*: And we find by Experience, that Nature has appointed each particular Kind of *Insect* to feed only upon a particular *Plant*; and even the same *Insect* that is appointed to feed upon the *Leaves* of a *Plant*, will not feed upon the *Flower* of the same; but the *Flowers* have equally different Kinds of Destroyers as the *Leaves* have; and I think such as feed upon the *Blossoms* or *Flowers* of *Vegetables*, change commonly into *Moths*; but the *Leaf-Eaters* are for the most Part *Butterflies*. Some of these, when they change from their *Caterpillar* State into a *Chrysalis*, inclose themselves in silken Bags: Others make their Retreat under some Shelter, or make their Way into the Earth while they are in this State. Their Figures are all different, as were their *Nymphæ*. And as the Time required for the hatching of the *Eggs* of the several Kinds is as various as themselves, so likewise the different Periods of Time necessary for the changing them from this stupified State to that of the *Fly* are as different; some of them only remaining  
thus

thus for a few Days, others a few Weeks, or some Months. What I here take notice of relating to the Food and Manner of breeding of *Insects*, especially that every distinct Kind of *Insect* has a *Plant* peculiar to itself to feed upon, I first learned from that excellent Lady the late Dutchess of *Beaufort*, whose Curiosity and Skill in natural Knowledge gave Life to many Discoveries, which, without her happy Influence, would have lain uncultivated and useless to the World. This Lady had seen the Progress of many Kinds, and I believe has bred a greater Variety of *English Insects*, than were ever rightly observed by any one Person in *Europe*.

When the *Papilionaceous* Race has got so far as to enjoy the Power of Flight, their extraordinary Frame and Colouring will afford us Matter enough for Admiration; especially if we could have an Opportunity of contemplating those surprizing Collections of Sir *Hans Sloane*, Mr. *Vincent*, Dr. *Ruysh*, and Mr. *Seba*, where we may observe many *Thousand* Varieties of Foreign *Insects*; and also in that curious Cabinet of Mr. *Dandridge*, who has so industriously collected the *Insects* of our own Country: Some of the *Moth* and *Butterfly* Tribe being so large as to measure 8, 9, and 10 Inches between the extreme Points of their *Wings*, especially those which breed about *Amboyna* in the *East-Indies*, and might certainly be propagated with us, if we had the proper *Plants* to feed



feed them with, and perhaps might produce something as useful as Silk, if we were to enquire into them. But while that Opinion reigns in the World, that we know enough already, and thereby the Search of Novelties is made ridiculous, we must be content to let many valuable Things lie undiscovered, as the *Load-Stone* did for many Ages. How useful are several *Earths*, *Vegetables*, and *Insects* in Medicine, and in some other Cases already discovered; and why may we not hope still to discover the hidden Virtues in other *such-like Bodies*. The *Silk-Worm*, at present, carries the Day before all others of the *Papilionaceous* Tribe, as it furnishes the Principles of the gayest and richest Clothing, although the Creature itself has the meanest Appearance of any of its Class. It is observed of this Race, that they seldom fly higher than 10 or 12 Yards from the Ground. And we may farther remark, that the *Butterfly* and *Moth* Kinds never keep in Flocks, as some other *Insects* do, although perhaps 500 are hatched together from the *Eggs* of one *Dam*.

Mr. *Dandridge* observes, that there are gradual Alterations from a perfect *Moth* to the *Bee* Kind; and indeed, if we examine the 26th Plate, we may find a just Progression from one to the other. The *Antennæ* of all are alike, and their Bodies are just different enough to be distinguished from one another, bearing about the same Proportions of Difference that an  
*Horse*

*Horse* does a *Mule*, or a *Mule* to an *Ass*. The *Wings* are 4 in each, those of the *Moth* feather'd all over : Next to which is a Degree of *Moth* with transparent *Wings*, feathered only about one 4th part ; the 3d with *Wings* like the 2d but thinly feathered on the Edges ; and lastly, the *Humble-Bee*, whose *Wings* have no *Feathers*. And so I doubt not but we might proceed as gradually thro' the *Bees*, *Wasps*, and *Ichneumon* Kinds, to the *Flies*, and such as have only 2 *Wings*,

I come now to speak of *Bees*, from whose industrious Race we are supplied with Food, as the *Silk-Worm* contributes to our Clothing. The Industry of the *Bee* has given some Authors occasion to write largely of them ; and such as have Glass Hives meet daily with some new Discovery worthy their Contemplation. The Method of building their *Combs* is so mathematically disposed, that the Skill of the greatest Artist cannot exceed the Justness and the Beauty of its Contrivance. The Hexagonal Figure of the Cells which compose the *Comb*, such as leaves no Vacancy or Space unemployed, but each respective Side of one Cell serves equally to make good Part of another, as it is well explained in the *Account of Bees*, in the *History of the Royal Academy of Paris for the Year 1712*. The Matter, of which the *Bees* make their *Wax*, is chiefly the *Farina Fæcundans*, or *Dust* of the *Apices* of *Flowers*, which they gather in small Parcels, and lodge in the Cavities of their *hind Legs*, and even upon the *Hairs* which



which are dispersed here and there upon their Bodies; for which Reason I suppose that *Bees-Wax* may contribute greatly to Vegetation. Upon the coming home of one of these laden *Bees*, we may observe how readily he is discharged of his Burden by others of the same Colony. I have seen about 10 or 12 *Bees* at work, to discharge one single *Bee* of the *Wax* he has brought home, and convey it to others which were employ'd in building and framing the Cells; nor is their Labour in gathering the *Honey* from the Bottom of the *Flowers*, nor their Discharge of it from their Bodies into the prepared Cells, less admirable. The Manner of their Breeding is yet Matter of Dispute; some Authors tells us, the *Queen-Bee*, which is always larger than the rest, is both *Mother* and *Queen* to the whole Colony; whereas, on the other Hand, the chief *Bee* of a *Hive* is stiled the *King*: But however this be, we find by Experience, that where this Governor is wanting, and has by Accident been destroyed, the whole *Hive* decays and comes to Ruin. I have with great Pleasure admired many of their Ceremonies about the Time of their Swarming, especially 3 or 4 Evenings before they are going out: The *Queen Bee* appears at the Mouth of the *Hive*, and is guarded at that Time by 4 or 5 Ranks or Files of *Bees*, who stand before her in strait Lines, fluttering their *Wings*, and making a Noise, without moving from their Place, leaving Room enough between the Ranks for the labouring *Bees* to pass back-

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wards and forwards. The Time of their Swarming is commonly in *May*, unless we have a Degree of Heat before that Season which is equal to the Temper of Air at that Time, as it sometimes happens in *February* or *March*. A curious Observer of *Bees* tells me, that he has known it practised, when a Swarm is inclinable to fly away, to fling Dust among them, or, if they are out of reach, the firing of a Pistol will make them settle immediately; which, I think, carries Reason enough along with it, considering how much an approaching Storm makes them hurry home to their *Hives*; I suppose, by pressing the Air in an extradinary manner, such as the firing of a Gun or Pistol will do. In short, their Oeconomy, their Battles, Robberies, Manner of Burying their Dead, and destroying their Drones, are Particulars surprisingly curious. As to the Make of the Body of a *Bee*, it is divided into 3 Parts, very tenderly joined together; the middle Part seems to contain the greatest of their Strength, and in it seems to be the chief Residence of the Power of Motion: To it are joined the *Legs*, which are 6 in Number; and the *Wings*, which are always 4 in the *Bee* Race, or such as have Stings like *Bees*. Some of the *Humble-Bees*, which come nearest in Form to the *Honey Bees*, have Stings; but others more remote from that Figure have none. The *Wasp* and *Hornet* are in most Particulars like the *Tame Bee*, and are not without the Skill of composing their *Cells* and *Combs* in as artful a manner as those



those of the *Bee* kind; but their Order and Discipline in other Matters do not seem so regular. All this Race have a Power of walking up such Surfaces as are as smooth as a well plained Board.

It is observable as well in the *Wasp* as in the *Bee* kind, that if we cut their Bodies to pieces, every Part will retain Life for many Hours, such as I have observed in the Flesh of *Eels* and *Vipers*; which seems to agree in some measure with the Life in *Vegetables*, whose several Parts, being separated from one another, will retain their Verdure for a long Time, and even be disposed to grow, if they are managed according to Art. Next to these we may place the *Ichneumon Flies*, which have generally 4 *transparent Wings*, 6 *Legs*, and the Body divided into 3, and joined by tender Vessels like the *Bee* Kind: Some of these lay their *Eggs* in the *Parenchymous* Part of *Leaves* and *Fruit*; others in the *Nympha* or *Caterpillar* of *Insects*; every one of them having a proper *Matrix* for the hatching of its own *Eggs*, or *Nidus*, distinct to it self, in some living Body considerably different from itself. I observe, that such as lay their *Eggs* in the *Leaves* or *Twigs* of *Trees*, do that Work while those Parts of the *Plant* are very tender, which they wound in such a Manner, and sprinkle with a *Liquor*, which they emit when they lay their *Egg*, as changes the first *Vegetative* Intent, and disposes the Parts of the *Leaf* or *Twig* to produce an uncommon Appearance, such as the *Blisters* upon the *Leaves* of *Oaks*, called *Oak-Berries*, and those *Excre-*  
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scences

*scences* called *Oak-Apples*, which are occasioned by these *Insects*, and serve as *Nests* to inclose, nourish, and hatch their *Eggs*. Those of the *Ichneumon* Race, which lay their *Eggs* in the Bodies of *Caterpillars*, have no further Care for the hatching of those *Eggs*; the Body of the *Caterpillar* affording them every Thing necessary, as well for their Hatching as their Nourishment, till they are fully perfected. Among the *Insects* I have bred, I have found many of the *Ichneumon* Tribe come out of the *Aureliæ* of the *Butterfly* and *Moth* Kinds, after having devoured all the Moisture of the Mother *Insect* which they were hatched in; this has made some mistake the *Aureliæ* of certain Kinds of *Butterflies*, to be the *Aureliæ* of *Ichneumon* Flies.

We next come to consider the *Beetles*, a Race of *Insects* whose *first* Food is, for the most part, the *Wood* and *Bark* of *Trees*: These have as many Changes as the former; the Structure of their Bodies in some Respects agreeing with those of the *Bee* Kind; the Bodies of these being divided into 3, but more strongly united together. The *Cases* of the Bodies in these is hard and substantial; their *Legs* are always 6 in Number, composed of a hard *Horney* Substance. They have 2 Pair of *Wings*, the uppermost very hard and strong, which serve for Cases for the other 2, which are thin and transparent, and so disposed as to fold up or expand themselves at the Will of the *Insect*. Their *Crest* or *Head* is hard, and commonly shining, and in most of them as black as  
Jett,



Jett, and of very surprizing Forms; some of them having *Pinchers*, like the *Horns* of *Bucks* and *Stags*; others have their *Heads* imitating the *Rhinoceros*; others have *Horns* like *Bulls*, and sometimes resembling the *Snout* of an *Elephant*, which makes us distinguish them by the Names of *Bull-Beetles*, *Stag-Beetles*, &c. They have 2 *Eyes* to see with, which demonstrates the Error of our old Proverb, *As Blind as a Beetle*. Their Time of Flight and appearing abroad is in the Evening; and the great Strength of their *Wings* and *Joints* is very remarkable, being able not only to resist a considerable Force, but even to support their Bodies in the Air, and carry them several Yards, with a Weight in their *Pinchers* of about 3 or 4 Ounces, such as a *Wand* of half a Yard long, and about half an Inch diameter, which I have seen our *English Stag-Beetle* fly with several Yards. The upper *Wings* of these Creatures are sometimes very finely variegated, and some of them appear as if they were made of solid Gold, shining thro' a transparent *Green*, *Blue*, or *Red*, Colour. The largest *Kind* I have yet seen, is the *Bull-Beetle*, whose Head and Body measures near 4 Inches; one of which *Kind* is now in the *Museum* of the Royal Society. The *Stag-Beetle*, from the *East Indies*, is likewise very large; and the Varieties of this *Kind* of *Insect* are generally of such remarkable Forms, that I think them no less worthy our Observation than the most curious animated Bodies. The Cabinets of Dr. *Ruysh*, Mr.

*Seba*, Mr. *Vincent*, Sir *Hans Sloane*, &c. are stored with these Rarities. Among these cased winged Creatures is the *Lady-Cow*, which has likewise its Varieties, beautifully spotted with the gayest Colours; and what gives me more than ordinary Satisfaction in contemplating this Kind of *Insect*, is, because there is good Reason to believe the *Cochineel* is of the same Tribe. That learned Apothecary, Mr. *Petiver*, has often told me, that in several Parcels of the *Cochineel*, he has found a Kind of *Lady Cow winged and perfect*, which he supposed was the *Cochineel Insect* in its mature State. And Monsieur *Lewenhoeck*'s Observations, in *Phil. Trans.* No. 292, gives me a farther Confirmation, that the *Cochineel* is an *Insect*; and upon the Foot of his Observations I have more than once made use of my *Microscopes*, to examine the Form and Structure of this valuable Creature, by which I was confirmed in many Things related by Monsieur *Lewenhoeck*, to whose Account I refer my Reader; but cannot help observing, that about 1718 I had a Present made me of some *Cochineel* which grew in *Carolina*, and was found upon the *Prickly Pear*, or *Indian Figg*, growing in that Country, by a Slave, who had once been employed by the *Spaniards* in catching and ordering *Cochineel* in their *American* Settlements; and I doubt not but it might be found in many other Parts of *America*, if we knew how to look for it. By what I could learn from the

Gentleman



Gentleman who brought it over, and had seen it grow, the *Insect* is not winged when they take it for Use, but rather in its third State, or laid up in its *Chrysalis*. He told me that some *hundreds* of them were found together in a Kind of *Silken Web*, which I suppose was of their own spinning, and seems to determine that they could be then in no other State but in the *Chrysalis*, and by the *Microscope* have an Appearance not unlike the *Chrysalis* of our common *Lady-Cow*. It was found upon Trial, that the *Cochineel* from *Carolina* was in every Respect as good as that brought from the *Spanish West-Indies*. For the better Satisfaction of my Reader, I have given him a Cut of the several Stages of our common *Lady-Bird*.

The next Tribe of *Insects* which I shall take notice of, is the *Locust*, or *Grasshopper* Kind, whose Race is as numerous as any I have yet mentioned, as may be observed in the above-named curious Cabinets, especially in that of Mr. *Vincent*. Their *Case Wings* are not so substantial as those of the former, but are as beautifully adorned. They have all 6 *Legs* a-piece; the two *binder Legs* chiefly disposed for Leaping, or raising their Bodies, till they can take *Wing*; but I can give no certain Account either of their Manner of *Generating*, or how they are brought forth, or proceed to their winged State. The Bodies of some of these are about 3 Inches long; and some Sorts that I have seen in Dr. *Ruysh's* Cabinet, measure 7 or 8 Inches.

It is observable, that this Race of Creatures have a Chirping Note or Voice, which is not remarkable in any other *Insect*, but the *Pediculus Pulsatorius*, or *Death-Watch* : For though other *Insects* make a humming Noise, I suppose that to proceed from the quick beating of the Air with their *Wings*, such as may be produced by whirling about a Bit of Stick at the End of a String. And although the *Master Bee* of a *Hive* is distinguished from the rest, by its different humming Tone, the superior Size of its *Wings* may as well make his Sound different from the rest, as the larger *Pipes* of his *Throat* (were they to be made use of as *Organs* of Sound) would produce a Note different from the smaller *Pipes* of the others, which are about one third less.

Next to these I place the *Libellæ*, or *Pond-Flies*, or, as some call them, *May-Flies*, or *Cadew-Flies*. The Bodies of these Creatures are divided into 3 Parts, as the *Insect* treated of before ; and the *Tail* Part of them is like the rest, composed of jointed *Annuli*. To the central Part of their Body are joined their 6 *Legs*, and 2 Pair of *Wings*, curiously wrought, and of a Texture like fine *Gauze* : Their *Eyes*, which employ the greatest Part of their *Head*, appear like *Glass* : The Colours of their Bodies are for the most Part tending to *Green*, *Blue*, or *Yellow* ; and I have not observed above 2 Kinds of them which have had any *Red* about them. Mr. *Dandridge*, and the late curious  
Mr,



Mr. *Petiver*, have both told me, that these *Flies* proceed from the *Cados-Worms*; but yet I have not been able to trace any one of these *Flies* to its original *Worm*. Nor can I be certain, whether the *Worms*, when they are cas'd over, as I have mentioned in my Chapter of *Fish*, are then in their *Chrysalis*, or feeding State.

We come now to mention those *Insects* which are always Inhabitants of the Waters, as well in their *Nymphæ* as in their perfect State, such as the *Water Scorpion*, *Cantharis*, *Water Beetles* of several Kinds, *Boat-Flies*, a *Mono-culus*, and *Cramp Spider*, besides several others of surprizing Modes and Forms, which may be observed by the Curious. The *Cantharis Aquatica* has but 4 *Legs* regularly set on to his Body, and the same Number of *Wings*, 2 of them *Case Wings*, and the others *thin* and *transparent*, which Mr. *Dandridge* tells me they have the Power of using even under the Water. The *Beetle* and *Water-Scorpion* are little various in the outward Structure of their Bodies, and have six *Legs* like the *Beetle* Kind upon the Land. But the *Boat-Flies* are very different from all other Kinds of *Insects*, having their *Legs*, which are very long, placed about the Middle of their Bodies; which serve as Oars to row them from Place to Place. The Shape of their Body is so like a common *Wherry*, that it gave them the Name of *Boat-Flies*. It is observable, that this *Insect* always swims

swims upon its Back. Dr. *Desaguliers* once shewed me many of this Tribe in a Drop of Water, wherein *Leather* had been steeped, which were so small, that the double *Microscope* did not make them appear half an Inch long ; and I suspect that they are *Insects* only in their *Nymphal* State. At the same Time the *Doctor*, in Presence of several Gentlemen, first gave me the Pleasure of observing a wonderful *Insect* which he had found in *Thames* Water, which had but one *Eye*, or perhaps one Globe of *Eyes*, placed in the Middle of its *Forehead*. This Creature may be very easily observed in the Month of *July*, which is the common Time of its appearing in great Numbers. Its natural Size is about the Bigness of a *Flea*, which obliged us to have Recourse to the *Microscope*, for the better viewing its Parts ; we then observed that the *Head* was somewhat like that of a *Bird*, firmly joined to the Body, which was of an *Oval* Figure, ending in a pointed *Tail*. The Parts which seem to do the Office of *Legs*, and fling this Creature forward in the Water by regular Springs or Jirks, are almost like the *Claws* of an *Eagle*, and are 2 in Number, placed on each Side of its Belly : On the Fore-part of its Body, near the Head, are placed 2 *Branches*, resembling the *Dugs* of *Animals*, from which proceed several capillary *Spines* ; these I did not observe had any Motion ; and if one may judge of them by their Appearance, we might suppose them designed for suckling



suckling their Young ; for this *Insect* is *Viviparous*, which is contrary to other *Insects* before mentioned ; for we did not only observe the young ones alive in the Belly of the Mother, but likewise saw several of them excluded from her Body. This curious *Insect* I delineated with all possible Exactness, with the Assistance of Dr. *Desaguliers*, and the Gentlemen then present.

The *Gnat* Kind next follows the *Water-Insects*, as they live the greatest Part of their Time in the Waters: Their Bodies, when they are in the *winged* State, are divided like those of the *Libellæ* ; they have six Legs a-piece, though the Number of their *Wings* is not always constant: Some Kinds have 4 a-piece, and the others but 2 ; but they are all *transparent*, and their Texture much like that of the *Wasp*, or *Bee* Kind. This Difference in the Number of *Wings* is somewhat like that which we observe between the *Bee* and *Fly* Kind ; and perhaps we might observe other as remarkable Differences as we do between the *Flies* and *Bees*: The 4 *winged* Kinds having, it may be, Stings, or some venomous Quality in them, and the others harmless as *Flies*. The Reverend Mr. *Derham* has observed above 30 several Kinds ; and has remarked the *Male* and *Female* either in *Coitu*, or has distinguished them by their *Antennæ*, or their Bellies, which are always larger in the *Females*, though unimpregnated, than in the *Males*. This curious Gentleman has  
given

given us a large Account of the Manner of the Generation of Gnats, in his excellent *Physico Theology*, where he tells us, “ That the *Culices* “ *Maximi*, or the largest Sort of Gnats, lay “ their Eggs in *Meadows* under the *Grass*; and “ there is one of the middle Sort which lays its “ Eggs in dead Beer *Yeast*, &c. but all the “ rest, which he had observed, lay and “ hatch in the Waters. The *Gnat*, which “ he mentions to lay its Eggs in dead Beer, “ hatches some time after into *Maggots*, which “ are so numerous, that the whole *Liquor* stir- “ reth as if it were alive, in which were observ- “ able, some that were larger, others smaller; “ the larger are the Offspring of our *Gnat*; the “ others of a small dark coloured *Fly*, tending “ to reddish, frequent in Cellars, and such ob- “ scure Places. All these *Maggots* turn to “ *Aureliæ*; the larger of which, of a *Tan* “ Colour, turn to our *Gnat*, which is of the “ unarmed Kind, having no *Spear* in its “ *Mouth*; its *Head* is larger than what is ob- “ served in the common *Gnats*, a longer “ *Neck*, short jointed *Antennæ*, spotted *Wings*, “ reaching beyond its slender *Alvus*; it is “ throughout of a *brown* Colour, tending to “ *red*, especially in the *Female*. The chief “ Difference between the *Male* and *Female*, is, “ as in other *Gnats*, (yea, most *Insects*) the “ *Male* is less than the *Female*, and hath a slen- “ derer *Belly*, and its *Podex* not so sharp as the “ *Female* is.

“ That



That curious Gentleman observes, “ that  
 “ such of the *Gnat* Kind as are of the Water  
 “ Race, lay their *Spawn* (some of them) above  
 “ an Inch long, and half a Quarter Diameter,  
 “ which floats in the Water. When these *Eggs*  
 “ are, by the Warmth of the Season, hatch-  
 “ ed into small *Maggots*, they descend to  
 “ the Bottom, where they make themselves  
 “ little Cases, which they creep into and out  
 “ of at Pleasure, until they are arrived unto a  
 “ more mature *Nymphal* State, and can swim  
 “ about to seek their Food; they are then a  
 “ Kind of *red Worm*, above half an Inch long;  
 “ it then enters its *Aurelia* State, and from  
 “ thence proceeds to its mature State, all as  
 “ different as to Shape and Accoutrements, as  
 “ if the *Insect* was three different *Animals*. In  
 “ its first or *Vermicular* State, it hath a Worm-  
 “ like Body, and swims about by Curvations,  
 “ appearing like the Figure of an S; but in its  
 “ *Aurelia* State it hath a quite different Bo-  
 “ dy, with a *Club-Head*, (in which the  
 “ *Head*, *Thorax*, and *Wings* of the *Gnat* are  
 “ inclosed) a slender *Alvus*, and a finny *Tail*  
 “ standing at right *Angles*, with the Body  
 “ quite contrary to what it was before; by  
 “ which Means, instead of easy flapping side-  
 “ ways, it swims by rapid brisk Jirks the quite  
 “ contrary Way; but when it becomes a *Gnat*,  
 “ no finny *Tail*, no *Club-Head*, but all is made  
 “ in the most accurate Manner for Flight and  
 “ Motion in the Air, as before it was for the  
 “ Waters.”

This

This Account, as I am satisfied it is exact in most of the Particulars, may lead my Reader into a right Method of observing the others, and perhaps give him an Opportunity of discovering other surprising *Phænomena* in this wonderful Creature. It is some of the *Gnat*-Kind, in their *Nymphal* State, which has oft-times given occasion to ignorant People to suppose that some Waters were turned to Blood; for I have seen Ponds and Ditches, about *Midsummer*, whose Waters appeared of a red Colour, having all their Bottoms cover'd with these Creatures in their *Vermicular* State, which disappear for some Yards Space upon touching only one or two of them, but creep out again of their *Cells* or *Cases* in a Minute or two, and reflect their *red* Colour in the Waters: Their Life is very short in their perfect State, their chief Business then being only *Generation*. I observe likewise, that the Time between the hatching of the *Egg*, and their taking *Wing*, is constant; which may be one Reason why we observe them hovering in Groups over or near the Waters, till they again return to lay their *Spawn*. Some of this Kind, as well as the *Cramp Spider*, are able to walk or stand upon the Waters. I have met with a Kind of *Gnat* that had but 4 Legs, whose Motion was performed in the same Manner of that of *Quadrupedes*. The Wings of these Creatures, and almost every other *Insect*, explain and expand themselves in a few Minutes, after they are

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excluded from the *Chrysalis*; and are not fully grown or explained, as some have thought, at the Instant the *Insect* quits the *Chrysalis*. I have observ'd with Abundance of Pleasure, at the first Appearance of the *Moth* or *Fly*, that their Wings were only beginning to bud; but have unfolded and explained themselves to their full State or Bounds of Growth, some in less than 2 Minutes, and others in 3 at most, which is a kind of *Vegetation* more speedy than has yet been mentioned; and I the rather chuse to call it so, because we cannot discern that the Wings of these Creatures have any Share of *Sensation*, especially such as are transparent; and their Method of joining to the Body of the *Insect*, is somewhat like the rooting of *Plants* in the Earth; they receive their Nourishment from the Body of the *Insect*, by those capillary *Tubes* which make the Junction between the Wing and the *Insect*. And if we consider farther, that the opening and explaining of the Wings of a *Moth* or *Butterfly*, is performed in about 3 Minutes; and that upon the same Wings there appears, almost in the very Instant of Time, a regular Plumage or Feathering, we must suppose the Time of the Growth of such *Feathers* must be almost instantaneous. I have observed some of the smaller Kind of *Gnats*, which have not lived above 8 Hours after they took Wing, having taken them just when they were excluded from the *Chrysalis*, and kept them under a Canvas Case. This Share of Life

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does not much exceed the Life of the *Ephemeron*, which is said to live but 5 Hours; but we must at the same Time take notice, that both the *Gnat* Kind and the *Ephemeron* have a Share of Life much longer under the Waters, altho' under different Forms. We may see the Account of the *Ephemeron*, with its *Natural History* and *Anatomy*, translated by Dr. Tyson from the Original of Dr. Swammerdam.

I now come to consider those *Insects* which are of the *Fly* Kind, agreeing partly in Figure, and some other Respects, with the *Bee* Race. All of the *Fly* Kind have but 2 *Wings* a-piece, and are without Stings; they make no Provision for Winter, as *Bees* do; nor do they seem to have any Order or Oeconomy among them. Their *Generation* is performed by Coupling; they lay *Eggs*, which hatch into *Maggots*, that afterwards lay themselves up in *Aureliæ*, and from thence change into *Flies*. The proper *Nidus* for their *Egg* is commonly Flesh of all Sorts, Dung of *Animals*, and whatever yields a Scent like *Carrion* entices them to it; and it is therefore they are so apt to swarm about the *Flowers* of the *Frittilaria Crassa*, that stinks like putrified Flesh, which is the Food for the *Maggots* of most *Flies* to feed upon. But it is observable, that all *Insects* are thus carefully led by Nature, to lay their *Eggs* in such Places, where their young ones may find convenient Food. There is indeed one Sort of *Fly* taken notice of by Mr. Dandridge, which tho' the  
Shape



Shape of its Body and Parts seem to agree very much with the common *Fly*, yet the Method of breeding its Young is very different. These *Flies* assemble together, and hang to one another in so great a Number, as to make a Lump or Ball of about 3 Inches Diameter: The Place of their Meeting is always upon some *Twig* over the Water, about *July* or *August*; while they are in that State, their Young-ones drop from them alive into the Water, after they have devoured all the Moisture in the Bodies of the Mother *Flies*. This *Fly* is of a Greyish Colour, and is the first of this Figure that I have heard of which is *Viviparous*, or that has its first Stage of Life in the Waters. Mr *Dandridge* has now a large *Bunch* of them in his Cabinet. From the same curious Gentleman I likewise received the surprising Account of the *Male* and *Female Glow-Worm*, which I delineated from those in his Collection, taken, *in Coitu*, by the Reverend Mr. *Maningham*, in which Creature the *Phosphoros* or glimmering Light they afford in dark Nights is not more remarkable, than the Difference of Frame and Parts between the *Male* and *Female*. The *Female* is flat and jointed, and is that which we commonly observe in the *Grass* and *Hedges*; but the *Male* has *Case-Wings*, and many Parts agreeing with the *Beetle-Race*; but whether it could produce a Light like that of the *Female*, I did not learn. The *Male* of this *Insect* having *Wings*, leads me to guess, that such of the *Pismires* as have *Wings* are *Males*,

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and

and perhaps leave the *Females* after they have made them pregnant, as the *Male-Bees* or *Drones* are said to do. In *Surinam*, and some other Parts of the *West-Indies*, there is a large *Fly*, which they commonly call the *Lanthorn-Fly*, that is said to yield a considerable Light. We have a good Cut of it in *Madam Mariana's History of Surinam Insects*, and the *Insect* it self is common enough in the *Amsterdam Cabinets*, and I think likewise in *Sir Hans Sloane's Collection of Rarities*; but I do not yet find any rational Account of the Production of these Lights, any more than of that produced by rotten Wood.

The *Ignis Fatuus*, or *Jack in the Lanthorn*, I suppose to be no more than a Group of small enlightened *Insects*, rather than suppose it an inflammable Vapour, as some have taken it to be; for if it consisted of such *Effluvia* or *Corpuscula* as rise from the Earth or Waters that were inflammable, and by some Cause or other had taken Fire, they could not be of such Duration. Besides, we might as reasonably expect, that all the *Effluvia* arising at the same Time from the same Body of Water should equally be inflammable as these, and so the whole Surface of the *Pond*, *Lake*, or *River*, appear all in a Flame at one Time. The sudden Motion of this Light from Place to Place, very much agrees with the Motion observable in the Groups of *Gnats* which move in a Body sometimes very slowly and at other Times drive together with great Swiftness. Happening to discourse upon this Subject



with the ingenious Mr. *Godfrey* the *Chymist*, he told me, that he had often observed this enlightened Body in some Places Abroad, and had caught some of the *Insects* which helped to compose it. But allowing it to be as I say, the Occasion of the Light in such *Insects* remains yet to be discovered.

But this strange Light has not given the Vulgar a greater Surprize than the *ticking Noise* which is commonly called a *Death-Watch*; and therefore I think myself obliged particularly to take notice of it, and satisfy those who are yet ignorant, that it is an *Insect*. The learned Dr. *Derham*, in a Letter to me, mentions 2 Sorts of the *Death-watch*; one is about the Bigness and Shape of a *Louse*, and the other a very small *Insect* made like a *Beetle*: These commonly are found in *July*, in dusty Places, where they are bred and feed. This curious Gentleman observes farther, that they *tick* only when they are about to *generate*; he gives us a Cut of the first Kind in its natural Size, and which with the *Microscope* I have copied from him; but the other Sort I have not been lucky enough to find, though there are many of them (as I am informed) in the great Library at the Royal Society. See more of this Creature, in *Phil. Transf.* No. 291.

The next Kind of *Insect* I shall take notice of, is of that Race which is called *Folium Ambulans*, or *walking Leaf*, which I have already treated of in my *New Improvements of Planting*

and Gardening: It is a Creature, which, if we take the Story of it right, partakes both of *Insectal* and *Vegetative* Life, being nourished, as I have observed, as well by the Juices of the *Tree*, which the Mother *Insect* lays its Eggs in, as by its own, which I suppose are so united, that one and the other circulate equally in the Body of the *Insect*, till itself, with the *Leaves* joining to it, drop from the *Tree*, and creep upon the Ground. I have therein given Figures of 2 Kinds of this Creature, which are *East-Indians*, and have referred to the Cabinets of Dr. *Ruysh*, and Mr. *Vincent* of *Holland*.

The *Insects* we come now to take notice of, are of the smaller Kinds, *i. e.* those in *Cheese*, *sour Liquors*, *Pepper-water*, *putrified Paste*, &c. The largest of these is the *Cheese-Mite*, which is however not big enough to have its Parts distinguished by the natural *Eye*, but must be observed with a magnifying *Glass* to describe its Appearance. We may remark, by the Help of *Glasses*, that this Creature, however *minute*, has all its Parts regularly framed, and its Motion agreeable to larger *Insects*, with 6 *Legs*. We may likewise be assured of its *Generation*, like other *Insects*, by the great Numbers a few will produce in a little Time, and every one of them of the same regular Figure. In *putrified Paste*, we may observe, by our *naked Eye*, a Motion, though we cannot discern distinctly what Bodies they are that move; but if we put the Quantity of a Grain of Sand of that



that moving *Paste* into the *Microscope*, and add to it as much *Water*, the *fourth Glass* of a good *Microscope* will shew them to be *Insects* of an *Eel-like Figure*, about an Inch long. In the *Lees of Wine*, and upon the *Outsides of Wine-Casks*, we find great Varieties of living *Creatures*, which are very proper Subjects for the *Microscope*; and even the *Mosses* or *Mouldiness* found in such damp Places as *Cellars*, and especially where *Wine* is kept, gives us very entertaining Prospects. *Vinegar* and *Pepper-water* likewise afford us Abundance of Variety; but because I have found it a little difficult to bring *Water* and *Pepper* into a right State of yielding these *Insects*, I shall take this Occasion to acquaint my Reader how I brought it to the Perfection I desired; for I do not know any Author who has yet given the Receipt. In *June* I took a Pint of clear *Water*, and put to it 5 or 6 whole *Pepper-Corns*, which I exposed in a *Porringer* to the open Air about 3 Weeks: I then found great Numbers of little *Animalcula* swimming in a small Drop of it; but in some *Waters*, where I had put beaten *Pepper*, I could not discover any *Insects*. We may farther remark, that if we put *Hair*, *Leather*, or any Part of *Animal Bodies* into *Water*, and let it stand for 3 Weeks or a Month, in *June*, *July*, or *August*, we find it filled with *Insects* of various Forms; but I suppose the several Kinds, observable in the several *Waters*, have not their Original in those Waters, but are severally pro-

duced from *Eggs* laid there by some *Mother Insects*, that are then in the Air, which respectively come to each of them, as to proper *Nests* or *Nurseries* for their Young; and I the rather am of this Opinion, because if we can keep such Bodies as usually produce *Insects* confined by Coverings of *Lawn*, or *Muslin*, we find no living Creatures in them. And again, as the *Mother Insects* are of such a diminutive Size, that they are not to be discerned without *Microscopes*, it is no wonder they can lay their *Eggs* in those Mixtures without being perceived; and I suppose the Air is full of them, especially in the Summer Months, the smaller Sorts serving as Food to the larger; and it may be therefore, that Nature has made the smallest Kinds more prolifick than the rest.

I shall conclude with some Account of the *Animalcula* in *Semine Masculino*, or of such minute Creatures as are found in the *Male Liqueur* of living Bodies, which some of the Learned suppose to be the Rudiment or Principle of the *Fœtus*. In taking this *Liqueur* from the several Kinds of *Animals*, we find by the *Microscope*, that such *Animalcula* are of different Figures and Bigness, as the *Animals* they were taken from differ in their Parts from one another. And these minute Creatures have so much Life and Spirit in them, that sometimes they remain alive above 3 Weeks after they are taken from their Parent *Animal*: The different Opinions concerning their Progress into the *Matrix* of



of the *Female*, I have before given in the Chapter of *Quadrupedes*; the Figures of one Kind of them is delineated below, *viz.*

*Explanation of the Plates relating to Chap. XII.  
and XIII.*

P L A T E XXV.

Fig. I. *The Bull-Beetle; from the Royal Society.*

Fig. II. *The Animalcula in Semine Masculino.*

Fig. III. *The last State of the large Gnat.*

Fig. IV. *A Centipes; from the West-Indies.*

Fig. V. *A Monoculus found in Thames Water, by the Microscope.*

P L A T E XXVI.

Fig. I. *Shewing the Gradation from the Moth A, by B. and C, to the Humble Bee D.*

Fig, 2. A: *A Water-Beetle.*

B: *Cantharis Aquatica.*

C: *A Water-Scorpion.*

D: *Cramp Spider.*

E: *Boat-Fly.*

Fig. III. A: *A Female Glow-Worm.*

B: *The Male Glow-Worm.*

All these are from Mr. *Dandridge's* Collection.

Fig. IV. *The Insect which blighted the Horse-beans in many Parts of England, Anno 1719, from the Reverend Mr. Laurence.*

## PLATE XXVII.

- Fig. I. A: *The Eggs of the Silk-Worm.*  
 B: *The Nympha, or Caterpillar of the same.*  
 C: *The Silk-Bag of the same, in which it changes into the Chrysalis D.*  
 E: *The Male-Moth proceeding from the Chrysalis D.*  
 F: *the Female-Moth proceeding from the same.*

Fig. II. A: *The Nympha, or Caterpillar, feeding upon the Nettle, which changes to the Chrysalis B, to the Butterfly C.*

Fig. III. A: *The Death-Watch, of its natural Bigness.* B: *The same with the Microscope; from the Reverend Dr. Derham.*

Fig. IV. A: *The Nympha of the Lady-Cow.* B: *The Chrysalis of the same: and C; The most perfect State.*

Fig. V. *A Prega Deos; from the East-Indies.*

Fig. VI. *An Insect, from Amboyna, whose natural Length is eight Inches; taken from the Cabinet of Dr. Ruysh at Amsterdam.*



## C H A P. XIV.

*Explaining the Use of the foregoing Remarks,  
with several Observations relating to CLIMATES.*

**I**N the preceding Chapters I have given a general View of many *Remarkables* in the *Works* of the *Creation*, and have disposed them in such a Manner, as may lead us to imagine, that *all* Bodies have some Dependance upon *one another*; and that every *distinct Part* of *Nature's Works* is necessary for the Support of the *Rest*; and that if any *one* was wanting, all the *Rest* must constantly be *out of Order*. It seems in this Case, as in that of Numerical Figures, each of which has a Power in itself of filling a certain Space, without which the several Gradations in Numbers cannot be expressed; and was there to be wanting any one of those Figures or Powers, the *Rest* could not maintain a gradual Progression of Numbers, but must frequently make such Breaks and Chasms as would run them into the greatest Confusion and Disproportion.

We observe so exact an Harmony between Natural and Mathematical Proportions, as might give every thinking Man Reason to believe the Latter could not have been without the Former; or that the Laws or Rules of Mathematics, as they now are, could not be  
just,

just, if Nature's Laws were different from what we now observe them to be. In whatever falls under our Observation in Nature's Works, we may remark a constant Regularity, and a just Symmetry and Proportion; the *Vegetables* have their *Roots* proportionable to the *Branches* and *Parts* they are to maintain; the *Animals* have their *Stomachs* agreeable to the Quantity of Food necessary for their Support; and even those *Insects* which are of the least Regard, have every Part disposed with such a just Regularity and Propriety, as to bear an Analogy with those in *Animals* of the greatest Esteem. The Frame and Figure of the Parts relating to every *Animal*, bears a right Proportion with the Body it is to move or direct: And the Length of Life in all Bodies is more or less, as any of those Bodies are later or sooner coming to their Perfection of Growth; for we observe, that such Bodies as are most speedy in their Growth, are proportionably short-lived, and of small Remain; and so on the contrary. In Music, there are 7 distinct *Tones* or *Notes*, which singly express a Power of *Sound* different from the Rest; and when any one of those *Tones* is laid down as a Ground-work, the progressive *Tones* from that *Ground-Note* to the *Octave*, which is the Resolve of the *Ground-Note*, declares the *Key*, either by a certain Number of *Semi-tones*, to express Melancholy, in what is called a *Flat-Key*; or by a greater Number of *whole Tones*, to make the Expression more brisk or poignant



nant to the Ear, and then is called a *Sharp-Key*; but whether the *Key* be *flat* or *sharp*, there is yet a regular Circulation of *Sound*, which is natural to the Ear, and may well enough be compared with the Circulation of Blood in the Bodies of 2 *Animals* of different Species, which though they both enjoy the Benefit of Circulation of Juices, the one is much brisker and more lively than the other.

The Distance between one *whole Note* and another may be divided into very minute Parts; but those who have to do with imperfect Instruments, such as *Organs*, *Harpsicords*, &c. content themselves only with *Semi-tones* and *Quarter-Notes*, in order to keep a tolerable Harmony in every *Key*; but a nice *Ear* may easily discover their Imperfection, especially when they are struck against a *Master-Note*. In perfect Instruments, such as the *Violin*, &c. every *Key* may be ordered by the Artist who plays upon it, to express any *Sound* with so great Exactness, that the *Ear* cannot discover the least Disorder or Imperfection of the Harmony, the Justness of which may be compared to a healthful Body; the Imperfection of the other to a Body distempered, where the Circulation is not just and regular; so we may learn, that where there is a familiar Gradation without Breaks, a Thing is natural, but otherwise unnatural.

To suppose that heavy Bodies can be raised on a sudden, with the same Certainty that we  
could

could move them by gentle Degrees, would make us guilty of an Error. The *Jack*, the *Leaver*, the *Wedge*, and such mechanic Powers, will, by gentle Operation, perform what the greatest Strength cannot perform on a sudden. A Man might jump down a Precipice and end his Life; but he might take Time, and walk perhaps a Mile or two, and gain the Bottom with Safety; it is natural therefore to go Step by Step. The Case is the same in *Animal* Bodies, but most remarkable in the Human Race; where, in Health, the Beats of the Pulse agree with the Vibrations of a *Pendulum*; but were we to provoke that Natural Course of the Blood to a quicker Motion, by invigorating Diet, should we not find the Body and the Senses indisposed, and even sometimes by Violence rob the several Parts of their natural Functions, and thereby occasion Death? Were we to examine the Circulation of *Liquors* in the several Kinds of Bodies animated, we find the *Squirrel*, and some others, to have naturally a much quicker Pulsation than Mankind; the *Snail*, and other *Insects*, have a Circulation of Juices much slower; but must we therefore conclude, that a Man is in Health because his Pulse keeps Time, either with that of an healthful *Squirrel* or *Snail*? The Parts of every distinct Creature are so ordered by Nature, as to receive, in a certain Capacity, the *Liquors* flowing thro' them; but were those *Liquors* to move either quicker  
or



or slower than Nature appointed, in each respective Body, the Body they moved in would be distempered.

Heat and Cold are comparative Terms. Fire we say is hot, and Ice is cold; but we say that Water is cold, and the Weather at *Midsummer* is hot; but this Heat, or this Cold, have their Degrees as much as Light and Darknes, or White and Black, or any other Colours. To say that a Thing is *Red*, is not to express what Colour properly it is of; there is the *Carmine*, the *Lake*, the *Vermilion*, and *Red-Leads*, which shew us there are many Degrees of that Colour. Again, the Degrees of Heat are innumerable; one will melt *Gold*, another *Silver*, another *Copper*, another *Lead* and *Tin*, another *Rosin* and *Wax*, and a lesser than these *Ice*. And now we come to say, that *Water* congeals into *Ice* by *Cold*; and, as some say, *Chrystaline* Bodies are consolidated by a continual extream *Cold*; but the hardening of *Water* into *Ice* happens only from a less Share of *Heat*, as the liquifying of *Wax* and some *Metals* is caused by a greater; so *Cold* is only a less Share of *Heat*, and so the contrary.

The Great and the Less have their gradual Differences. A *Grain* of *Sand*, and the *Terraqueous Globe*, one may suppose at a vast Distance from one another, with Respect of Magnitude; but alas! were we to make Comparison between the *Globe* of *Earth* and the other *Planets*, we should find a Difference almost as extensive

extensive as between the *Grain of Sand* and our *Globe*; but between these Points of Magnitude there is Room in Thought for innumerable Distinctions; so is it in the Appointment of Numbers, they seem capable of infinite Division and Increase. The *Tones* or *Notes* of Music are as divisible. The gradual Increase of Mechanic Powers is as extensive, and the *Vegetation* of *Plants* is as gradual, as well as the Life and Growth of *Animals*. It is therefore in this *Foundation* of *Natural History*, we have supposed a *Scale of Life*, or a Chain of created Beings; for if our Reason tells us we ought to move gradually, there is certainly a *Gradation* in *Nature*, and therefore that gradual Motion is natural and reasonable; and whatever is not so, is contrary to Nature and Reason; and I do not know a better Way of bringing the Unlearned to a right Judgment of Things, than by giving them a general View of Nature's Works, which at the same Time may lead them into the Way of Reason, and shew them the Wisdom of the CREATOR.

All our Senses are Witnesses of the Gradations in Nature, by which we are taught to act with Gentleness and Deliberation in such Things as are to be durable; for whatever is too hastily gone about, or is forced to greater Speed than Nature appoints, must inevitably perish before its due Time; and it is from a just Observance of such progressive Methods as Nature



Nature takes in the ordering and directing her Works, that our Reason is guided truly to our Advantage.

From Considerations of this Kind we may learn how ridiculous it would be to suppose, that because a *Plant* cultivated in the Torrid Zone, required a greater *Heat* than we enjoy in our *Climate*, to support it in a due State of Health, that therefore the Heat of a Furnace would give it a quicker Vegetation; or, to conclude, when we had killed a *Plant* or an *Animal* by an extraordinary Warmth, that therefore Nature directed it should have none at all. There are certain Degrees to be chosen, agreeable to those appointed by Nature, for the Support of each respective *Plant* and *Animal*; nor ought we to suppose, that because we find a Gardener raises a prosperous Crop in one Place, we may have the same Success in another, without thinking reasonably upon the Difference of the Soil or Situation: But yet have I known many Instances of Men, who have been Sufferers, by acting without Understanding in Cases of this Nature. Some, who have been enriched by a *Clay*, have been undone by following the same Rules upon a *Sand*; others have so far out-done *Natural Heat*, that they consumed their Gardens, and destroyed all they had, without regarding that Nature has her Laws, which must be obeyed, and that she acts with Gentleness, and will not be forced out of her Way. Thus it appears,  
that

that an Art is only the true Knowledge of Nature, and that those who do not really know the natural Foundation of what they profess, are not Artists.

The more particular Use of this Scheme to Gardeners is, by directing them to consider, that as every distinct *Animal* has its *Climate* and *Food* natural to it, so has every *Plant* an *Exposure*, *Temper* of *Air*, and *Soil*, proper to nourish and maintain it in a right State of Health: And again, as we find some *Animals* to delight in the *Waters*, some in open *Air*, and some under the *Earth*; so are there *Plants* likewise that have their respective Appointments in the *Waters*, as the *Lens Palustris*, or *Duck-Meat*; and in the *Air*, as most *succulent Plants*; and even under the *Earth*, as the *Truffle*; so in all Plantations we make, we ought to observe what *Element*, *Situation*, and *Soil*, relates to each, if we would be sure of Success.

To judge rightly of the Method of treating *Plants* brought to us from several Parts of the World, I consider *two* Things. *First*, The *Soil* of the Country they grow in, which I would imitate as near as possible. *Secondly*, The Time of the *Spring* in the Country they are natural to, and as near as may be the Degree of *Heat* in that Time of *Spring*: For as every *Plant* has its appointed Times of Rest and Growth, it would be unnatural to force its Growth, when Nature ordained its Repose,

or



or to abandon it to Repose, when it should be assisted by a Warmth agreeable to its own Country *Spring*.

To know the Time of *Spring* agreeable to every *Plant*, is to learn the Latitude of the Country it grew in; and in the next Place, to consider the Degree of *Heat* natural to that *Climate* in the Time of its *Spring*. To judge of the Time of the *Spring* in every Country, is to observe in what *Zone* it lies; whether in the *Torrid Zone*, i. e. between the *Tropics*, or in the *Temperate Zones*, i. e. from each *Tropic* to the nearest Bounds of the *Frigid Zones*, or from the *Polar Circles* even to the *Poles* themselves.

The *Plants* which grow between the *Equinoctial Line* and the *Tropic of Cancer*, or to the Northward, (i. e.) towards us, we suppose to have their *Spring* as soon as our Days lengthen: And as the *Sun* comes towards us more and more, all the Places between that *Line* and the *Tropic* are gradually enlivened with *Spring*. At the same Time, while the *Sun* moves this Way to its *Boundary* or *Tropic*, which is about 23 Degrees North Latitude, the Influence of it has its Operations on every Thing gradually from the *Tropic* to the *Polar Circle*, and from that to the *Pole* itself: So that if we judge of the Latitudes, as they are gradually placed in the *Map*, and the Times and Degrees of *Heat* progressively moving thro' them, we cannot fail of giving every *Plant*,

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from

from any Part on this Side the *Line*, its Force or Warmth at the right Season; and so we must maintain a due Regard to such *Plants* as are Natives of those Countries on the other Side the *Line*. When the *Sun* begins to leave us, their *Spring* is then coming forward, and every Day increases as much that Way, as we on the North-side of the *Line* decline into *Winter*; so that whatever *Plants* we have from thence, we ought to help at that Time, as we would our own in our own *Spring*.

We are moreover to remark, that as the *Sun's* Motion and great Influence is between the *Tropics*; and that every Year its Motion is from South to North, and back again; so that Motion will produce two *Springs* every Year in each of the Countries it passes over; which *Springs* we may judge of, by enquiring into the *Sun's* Course, which a common *Almanack* will shew us; and then allowing about 6 Weeks for the *Sun's* Progress, before it can be directly over the Place we pitch upon, I suppose that will be the Time of *Spring* in that Country; for when the *Sun's* Power is most violent in any Place, we find all *Plants* have finish'd their *Spring* Shoot, as we observe in *England* at *Midsummer*, when the *Sun* is nearest to us. In the *Temperate Zones*, such as we have the Happiness to enjoy, tho' the *Sun's* Influence is more moderate, yet we may observe that the greatest Share of *Heat* only serves to ripen our Fruits; but it is the gentle Warmth

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gradually increafing, like that of *April*, which makes our *Plants* vegetate.

When the *Spring-Shoot* is perfected, and the great *Summer-Heat* is over, Nature begins to make a fecond *Shoot*; but that *Shoot* is feldom of any great Confequence with *Us*; the *Sun's Heat* declines, when our *Plants* want it to increafe, and the Attempt of Vegetation proves vain. I am of Opinion, were we then to give thofe fhooting *Plants* a convenient Shelter, and an additional *Heat*, regulated by a *Thermometer*, fo that it fhould be equal to that in the Month of *April*, we might even bring them to bear Fruit in the *Autumn* Seafon. I have known fome *Trees*, which, without any Help, have ripen'd fome few Fruit of the fecond *Spring*. It is common enough in *Strawberries*, *Rasberries*, and *Cherry-trees*, efpecially if the *Bloffoms* of the *Spring* have been taken off at their firft Appearance.

When we have confider'd the Time of *Spring* in the feveral Countries of the *Earth*, from whence we receive *Plants*, we are next to enquire the Degrees of *Heat* in each of thofe Places at the Time of their refpective *Springs*, which we muft imitate as near as poffible; and I obferve, that our *Midsummer-Heat* is powerful enough to maintain any *Plant* brought us from between the *Tropics*; therefore, as we have it in our Power to give that Degree of *Heat*, at any Time of the Year, by means of Fire, we may keep any *Plant* even from un-

der the *Line*, in our Conservatories, regulated by a *Thermometer*, at our *Midsummer* Degree of *Heat*, which I suppose will agree well enough with the *Spring Heats* in those Countries lying between the *Tropics*; and at the same Time I would have an *Hygrometer* in the same Stove or Conservatory, by which we might regulate the over Moisture or Damps in the Air of the House.

The Air in *England* is generally so temperate, or the Passage from the *Heat* to the *Cold* is so gradual, that *Plants* which naturally grow 8 or 9 Degrees more South than we are, will grow here without any Shelter; but indeed they have this Advantage, that the Time of their natural *Spring*, or awaking from their Rest, is but a little different from the Season of our *Spring*; so that when Nature appoints them to make their Shoot, the *Sun* is coming towards us, and retards them in their Attempt.

In my *Kalendar of Gardening* I have given a Design of a Green-house or Repository for *exotic Plants*; but for the Preservation of the most tender Kinds, such as grow near the *Line*, there is no one does so well as that contrived by the curious Monsieur *Le Cour* of *Leyden*, for the Production of that most excellent Fruit called the *Ananas*, or *Pine-Apple*, from whose Model there are 2 or 3 now built in *England*.

I think I have said enough to inform my Reader how necessary it is to observe the Laws of Nature in the Preservation of created Bodies,



dies, tho' I am not insensible that even the Contemplation of one created Body alone would afford Matter sufficient for a large Volume; but my Design being only to exhibit a general View of Things, rather than to enter upon Particulars with too much Freedom, I chuse to leave the Enquiry into the more nice Parts to the Curious, who have Leisure and Opportunity to observe them.

I shall conclude with some Particulars relating to MANKIND, who, altho' he be Lord of All, and has a Power of governing every living Creature, yet has he many Particulars in his Frame which bear Analogy with the Parts of those Creatures he is ordained to govern. The Harmony which Nature maintains in the Generation and Production of *Quadrupedes*, is not contradicted in HIM. The Functions of several Parts in Brutes direct to perform what the same Parts would do in Mankind, was he not indued with Reason to guide him in his Actions, and over-rule what is brutal in him. But this is a Matter which relates more particularly to those who make it their Business to consult the Health and Welfare of Men, rather than their Natural History, which is my present Subject. I shall therefore content myself with observing only some remarkable Particulars, which are not commonly taken notice in the Human *Species*.

The Longings in Women, and the Marking of Children, are Subjects which have occasioned

Disputes among the Learned; but I do not find either of those Cases yet determined, so that I cannot well omit a Conjecture or two of my own relating to those Subjects. I suppose when a Woman is pregnant, there is a regular Circulation of Juices thro' the Bodies of both the *Mother* and the *Fætus*, admitting only that the Parts of the *Fætus* subsist or are supported by such fine Juices as we may say are distilled from the Blood of the *Mother*; for the Parts fully grown are undoubtedly more capable of giving Passage to more gross Juices than those which are in *Embryo*, and in such a minute Body; and in the *Fætus* must be as fine as a subtle Vapour, almost equal to those Spirits which nourish the *Brain* of a full-grown Body.

The *Fætus* has its Head first formed, and that, as well as all the other Parts, is regularly supplied with Juices from the several Parts of the *Mother*, as they are analogous to one another; therefore, I suppose, as the *Brain* both of the *Mother* and *Fætus* have an immediate Communication with one another, so I imagine the extraordinary Desire of the *Mother* has so immediate an Effect on the *Brain* of the *Fætus*, that it becomes distempered, and consequently must affect the *Brain* of the pregnant Woman, and so both are out of Order.

Again, the pregnant Woman, by touching any Part of her Body, when a strong Desire of any thing predominates in her *Imagination*, must have an extraordinary Power over the  
same



same Part of the *Fætus*, and especially because Things so small and flexible will sooner take an Impression than others which are perfected; but this by way of Hint to the Learned. I proceed next to observe the several Kinds of Men, whose Difference is remarkable.

There are 5 Sorts of Men; the *White-Men*, which are *Europeans*, who have *Beards*, and a Sort of *White-Men* in *America* (as I am told) who only differ from us in having no *Beards*. The 3d Sort are the *Mulattoes*, which have their *Skins* almost of a *Copper Colour*, *small Eyes*, and *strait black Hair*. The 4th Kind are the *Blacks*, who have *strait black Hair*: And the 5th are the *Blacks* of *Guinea*, whose *Hair* is curled, like the *Wool* of a *Sheep*. Such are the Marks of Distinction; and the Behaviour observed between rude and civilized Nations, is to be wholly attributed to the Arts of polite Education.

*Explanation of the Figures relating to Chapter XIV.*

## P L A T E XXVIII.

Fig. I. *The Eggs taken from the Ovary of a Woman; by Dr. Douglas.*

Fig. II. *An Human Fœtus before Quicken- ing, from the Royal Society's Collection.*

Fig. III. *An Human Fœtus after Quicken- ing, from the same.*

## P L A T E   X I X .

Fig. I. *A Skeleton of a Man, whereby the Difference in the Osteography in the Man, and other Creatures, may be observed.*

Fig. II. *The Skeleton of a Monkey, shewing the Difference between that Creature, and the Human Species.*

## C H A P.   X V .

*An Account of such Lands in England as are stiled Barren, with some Propositions tending to their Improvement, and some Remarks relating to Fish-Ponds.*

**I**N my Book of *New Improvements in Planting, &c.* I have endeavoured to excite our *English Nobility* to plant Timber, as well for the Use of their own Families, as for the publick Good; and since I find that Work has not been disagreeable, I am the more ready to publish what I have since observed in the Culture of profitable *Trees*, and the Method of Improving what we now call *Barren-Lands*. I have often viewed our *desolate Forests*, and *barren Plains*, with an Eye of Pity, considering how much we were at the same Time beholden to distant Nations for those Commodities, which might with Ease be cultivated in our own Country,  
and



and which might turn to great Profit, and secure us from the Assaults of incroaching Neighbours.

In my Travels about *England*, I observed that we have 3 sorts of Soil, which are generally accounted unprofitable, such as *Heath-Grounds*, *Chalky-Hills* and *Plains*, and that which affords only what is called *dead Sand*. Some of the *Forests* indeed yield good profitable *Land* for *Corn* and *Pasture*, and have formerly borne valuable Burthens of *Trees*; as have also some *Grounds* belonging to private Gentlemen, from whence, upon Emergencies, have been reaped considerable Crops of *Timber*, whose Price has even overbalanced the Worth of the *Ground* it grew upon. And we have many late Instances of Estates which have been sold, whereon, in a few Years afterwards, the *Timber* produced has yielded more Money than was given for the whole Purchase of the *Land*. In my former Works upon this Head, I have rated *Land* for *Timber* at 5 s. *per Acre*; but such *Lands* as I am here treating of have been sold for 1s. *per Acre*, and less.

The *first* I shall take notice of are the *Heaths* in *England*, which at present scarcely yield Food enough for *Sheep*, and are of no other Use. This sort of *Land*, which is generally sandy, and in which commonly we find abundance of *morass* Ground, I advise to be cultivated for the propagating of *Fir-Trees*, which are of very quick Growth, useful, and agree well with such *Land*. We have some Instances of this sort of  
*Land*

*Land* cultivated in this manner; but in *Germany*, and some of the North Parts of *Europe*, we find whole *Forests* of *Firs* growing in this kind of *Soil*. At the Earl of *Alresford's*, near *Guilford* in *Surrey*, we have an Example of the good Thriving of these *Trees* upon a *Hill* of common *White Sand*, (in which one could hardly expect the least *Vegetable Quality*) and yet they have not been planted quite 30 Years, tho' they are now above 40 Feet high: But it is to be observed, they are hardly 6 Feet asunder, which may be the Occasion of their extraordinary Height, and the Clearness of their *Stems*, without Knots. The Experience I have had of this *Tree*, especially of the *Scots Fir*, teaches me, that it thrives better raised from *Seed* upon the Spot where it is designed to remain, than if it be transplanted.

To make a Seminary of these *Trees*, we gather the *Cones* or *Fruit* of them in *September*, even while their *Rind* partakes yet of a *Green Colour*; for those *Cones* which are already cracked and opened, produce little or no good *Seed*. The *Cones* being thus gathered, we lay them in a dry Place during the Winter, and about *February* either expose them to the Sun till they crack and open, or else put them in some Vessel into an Oven after the great Heat is gone off. By either of these Ways we come at the *Seed* without Difficulty, as I have tried with good Success; tho' some have been apt to suspect, that those *Cones* and *Seeds* which are opened



pened by the Heat of an Oven, would be too much dried to *vegetate* or *spring* in the *Ground*: When these *Seeds* are well cleaned, we sow them thin in Beds, covering them about half an Inch deep with fine Earth, and in a Month's Time they come up; but we must take great Care at their first Appearance to preserve them from *Snails*, which are their worst Enemies. The same Summer they shoot hardly more than an Inch; and as their *Roots* lie very near the Surface, it is advisable to sift *Sand* over the Beds near half an Inch thick, about *September*, to keep them steady, and prevent the Frosts from turning them out of the *Ground*. The 2d Year they make *Plants* of about 4 Inches high; and if they were to remain in the same Bed the 3d Year, they would be near a Foot taller; but I hold it much better, if any of them are to be removed, that it should be done when they are 2 Years old, and even then with extraordinary Care, laying them in a Barrow or Case of Earth, to be transported to the Place appointed for the Great Plantation; and observe, that we do not take them out of this Earth, till the very Instant, if possible, that we are to place them in the Station where they are ever after to remain; for a little Air dries and shrinks the Coat of their *Roots*, and their *Parenchymous* Parts; so that they remain for a Time without the Power of Growth, and perhaps rot or grow distempered by a Stagnation of the Juices. In this Plantation I would not advise

advise to set them more than 6 Feet apart ; which would be a Means, as I have observed before, of their growing strait and tall, unless indeed we would run the Hazard of transplanting some of them a second Time, and then the Distance between them need not be above 3 Feet, which would yet contribute so much the more to their aspiring and upright Growth, during their juvenile State. They might remain in this Manner about 5 or 6 Years, and then it would be high Time to draw every other *Tree* to make Room for the rest. The Method which has been used for transplanting *Fir-Trees* of this Age, and even some Years beyond it, with good Success, was invented by the honourable *James Johnston* of *Twickenham*, Esq ; who about *Midsummer* transplanted some of these *Trees* above 20 Feet high, in a Preparation of *Earth* and *Water*, of the Consistency of a thin *Mud*, filling it up with fine *Earth*, till the *Root* of the *Tree* was firmly settled in it. By this Means, the *Trees* so planted, had made Shoots on their Tops above a Foot long the following Year, before the others, (which remained in the Nursery) had even begun to shoot.

I have before taken notice of a new-invented Method of transplanting *Trees* with Safety, by Means of a *Vegetable Mummy*, or Compositions of *Pitch*, *Bees-Wax*, *Turpentine*, and such like ; and I believe it would be of no small Use in this Case, especially if we were to transport *Trees* to any great Distance. The anointing the  
*Roots*



*Roots* with such Preparations, and especially those Parts where they have been cut or wounded, would keep them from drying, or shrinking up by the Air or Sun, and even contribute somewhat to their Growth. For the *Fir*, indeed, I rather recommend the anointing the *Roots* with *Turpentine* alone, or else mixed with *Tallow*, which might easily be done with a Brush when it was warm; for the *Turpentine* I suppose cannot fail of giving some Nourishment to the *Tree* which naturally produces it; and the *Fat* of *Animals* is generally allowed to assist *Vegetation*, as I have before observed, where I recommend the Use of *Soap*, to anoint the *Roots* of *Vegetables*, to which I refer.

The *Scots-Fir* and *Pinaster* are what I chiefly would advise to be planted for *Timber*, in *Sandy* and *Heathy Ground*, as they are both able to maintain themselves in Variety of Seasons. I have seen both these Kinds yield profitable *Timber* for *Plank* or *Boards* in 40 Years from the setting, as the People now living have assured me, that saw them planted and raised from *Seeds*. A Gentleman of *Devonshire* has now many of them growing upon a *red Rock*, where they thrive exceedingly; so that the *Hills* in *Derbyshire*, and such as are rocky like them, need not despair of bearing one Time or other this profitable Burden. But least 40 Years should be thought too long Time to wait, without receiving any Advantage, let us con-

sider

sider the *Ground* was before the Plantation good for little or nothing ; and in half that Time, the *Plants* which may be drawn out to thin the rest will be fit for Scaffolding, or some other Uses ; and all this while, the growing *Trees* are increasing in their Value, without any Expence or Labour, more than the first Charge.

But as *Heath Ground* is the Soil I propose for such Plantations, and is for the most Part in Common, it will be difficult to inclose it. I think, however, the best Method to overcome that Difficulty, would be to *summon* the Poor of the Parish, who have chiefly *the Right of Commoning*, and *parcel out* such *Land* in as many Lots as there are Persons who can justly claim a *Right to* it ; and then the Choice among them, of the respective *Parcels of Land*, to be made by balloting, or else let them chuse according to their Seniority, or the Length of Time that each of them, or their Families, have been Inhabitants of the Parish : By this Means every one of these poor People would find Matter of Employment, and become Possessors of *Land*, which they might justly call their own, and thereby have Encouragement to cultivate and improve it : These People still being tributary to the Lord of the Manor, in proportion to the Value of such Lands as they hold, and to be obliged also to plant a certain Number of such *Trees* for *Timber* as the *Land* will best nourish. It is my Opinion, that many of our Poor, which at present are troublesome and  
expensive,



expensive, may by this Method be rendered useful to the Publick, and live in a contented State, enjoying every Man his own Right, without Incroachment from his Neighbours, or being subject, as the Commoners now are, to have the Benefit run only into a *few* Hands, while perhaps those who have the greatest Right have hardly Pasture enough for 6 *Sheep*, when others find Subsistence for 2 or 300.

Another Way, which might tend to the Improvement and propagating of *Timber*, would be by obliging every Tenant at the renewing of his Lease, to plant certain Numbers of *Trees* at his own Expence. Where any considerable Plantation happens to be made, I would advise a *Stone* to be set up, with an Inscription, denoting the Year, the *Season*, and by whom planted, that it might be an Instruction to future Ages how long such *Trees* had been growing, to produce the Sum they might then be sold for, and inform the Successor of the Person's Name, who so wisely had the Foresight to provide for him.

The other Sort of *Ground*, which next falls under my Consideration, is the *Chalk*, such as we observe, for the most Part, on *Salisbury-Plain*, and the waste Grounds about *New-Market*; and I much wonder, considering the great Scarcity of *Timber* and Fire-Wood in those Countries, that no body has yet began any Plantation thereabouts, especially since we have so many Instances of *Hills* and *Lands* of the same Kind of *Chalk* in *Berkshire*, *Oxfordshire*,  
*shire*,

*shire, Buckinghamshire, &c.* which are covered with stately *Trees*, as well for *Timber* as *Fire-Wood*. We there find the *Beech* is natural to that Kind of Soil; and in some Places the *English Chestnut* thrives pretty well, and the *Oak* indifferently; but the *Wallnut* rejoices in that Soil, if it has any tolerable Shelter. I would recommend therefore to such Gentlemen as have Estates about *Salisbury* and *New-Market*, to take the *Hills* and *Chalky Grounds* of *Berkshire, &c.* for their Example, and cultivate their *Lands*, which are of the same Kind, after the same Manner; so that in Time they may save the Expence and Trouble which they are now at, in sending many Miles for their *Firing* and *Timber*.

The *Beech*, which is a Lover of this Soil, grows much quicker in it than in some *Lands* which are counted much richer, and is raised from the *Mast* without any Difficulty, carrying this Conveniency along with it, that the *Seed* does not come up till the 2d Year; so that upon the first ploughing of the *Ground*, we may sow the *Beech-mast*, and some Kind of *Grain* at the same Time, and reap a profitable Crop of *Corn* before the young *Beech* appears, to bear the Expence we have been at in laying up the *Ground*. In 12 or 14 Years we may begin to reap some Advantage from this new *Wood*, by cutting and thinning such of it as is fit for *Firing*. If we had an 100 Acres planted in this Manner, we might cut about an 8th Part at one Time,



Time, and at that Rate have a continued Supply from Year to Year; the first growing up by that Time we have cut the last; and the last renewing itself again by that Time the other 7 Parcels have had their 2d Cutting.

The *English Chesnut* is likewise a very profitable *Tree*; and though I have already mentioned it in my *New Improvements of Planting*, &c. yet I cannot help taking notice of the extraordinary Bulk that *Tree* will grow to. Mr. *Greening*, a very ingenious Nursery Man at *Brentford*, tells me, that at the Seat of the Lord *Ducie Moreton* at *Tartworth* in *Gloucestershire*, there is now growing an *English Chesnut*, which he measured, and found the *Girt* 51 Feet about, 6 Feet above Ground. This *Tree* divides itself at the *Crown* into 3 *Limbs*, one of which he measured 28 Feet and a half in the *Girt*, 5 Feet above the *Crown* of the *Tree*; which extraordinary Measure of the *Limb* only, is almost equal to the biggest *Oak* in *England*. He observed that the Soil was a soft *Clay*, somewhat loomy, and the Situation on the *North-West-Side* of a *Hill*: This *Tree*, he tells me, was mentioned in a Book Dedicated to King *John*, and was then stiled the *Great* or *Old Chesnut Tree* at *Tartworth*; so that it is supposed it must be above a 1000 Years old. At the same Seat, near the Place where this wonderful *Tree* now grows, my Lord *Ducie* told him he lately cut down an *Elm*, out of whose *Limbs* were made 100 Pair of Stocks for Cart-Wheels, and whose

Body was sold for 22 Guineas upon the Spot ; from whence we may learn how a *loomy Soil* contributes to the Growth of these Kind of *Trees*.

In *Marshy Grounds* the *Osier*, *Alder*, and *Arbeel*, turn to good Account; and may every one of them be raised from *Cuttings*, or *Truncheons* set in the *Ground*, ( as I have directed in my Book of Gardening ) even tho' it be covered 2 or 3 Feet deep with *Water*; especially the *Osier* and the *Alder* would in Time, by the matting or entangling of their *Roots*, and continued Fall of their *Leaves*, bring it to solid *Ground*; but *Water* in some Cases is as profitable as the *Land* itself, as I shall soon observe; but first let me advise that where *Banks* are necessary to keep *Land* from the overflowing of adjacent *Rivers* or *Lakes*, there is no Way of making them so solid and lasting, as by Backing them well with *Stakes* of *Willows*, which strike *Root* without any Trouble, and intermix with one another in such a manner, that in a few Years only they become as one Body.

I come now to speak of *Fish-Ponds*, and to mention some Observations concerning the Number of *Fish*, which a certain Quantity of *Water* will maintain. It has been observed, that every Kind of *Fish* requires a certain Depth of *Water* to maintain itself in; the smaller Sorts delighting and thriving in shallower *Waters* than the greater; and these *Waters* are more or less nourishing to some *Fish*, as they pass thro' different



different *Strata*, or Beds of *Earth*, every Kind of *Earth* giving its *Tincture* to the *Waters* passing thro' it, or joining with it. The most nourishing *Waters* for *Carp*, are such as are found in *Heathy-Grounds*, which are commonly of a *Sandy Soil*; and if it is possible to chuse the Situation of a *Pond*, it is counted much better to have it near the Bottom of *Hills*, that upon the Fall of great Rains may wash down *Insects*, and other nourishable Matter into it; and if it could be contrived, the *Water* should be always current thro' it; where this happens, the same Fund of *Water* will maintain one third part more *Fish* than it would do, if it was only a still *Water*. In the making of a *Pond*, we ought to contrive, that it may have all Degrees of Depth as far as 6 Feet; for if the *Fish* happen to breed in it, the young *Fry* or *Spawn* must have shallow *Water* to live and swim in; and the *Spawn* itself, while it is in the *Egg*, would be unfruitful, was it to lie in deep *Water*. Again, as the young *Fish* grow bigger, they change their Station more and more towards the Deep, till they become of a fit Size to breed and produce others. It is rarely known, that in a good breeding *Pond* the *Fish* ever come to be very large; for the Number of them become so great, that they over-stock the *Water*, and are straitened for Food. I have been told, that where the shallowest Part of a *Pond* is about 2 Feet in *Water*, that neither *Carp*, *Pike*, *Tench*, or *Perch*, will breed in it,

because it is too deep for the *Spawn* to hatch, if the *Fish* should be inclined to lay any; and in such Places an ingenious \* Gentleman observes the *Fish* grow very large, and thrive a-pace, if they were at first rightly proportioned to the Quantity of *Water*, and put in at a right Age. An Acre of *Water*, he tells me, (if all the Parts of the *Pond*, one with another, measure 3 Feet deep) may well enough bear 90 Brace of *Carps*, which is about a Rod of *Water* to each *Fish*; or else, as he observes, 80 Brace of *Carps*, and 20 Brace of *Tench*, and so in Proportion for every 10 Brace of *Carp* wanting, he allows 20 Brace of *Tench*. These *Fish*, he supposes, delight to be together; and remarks, that the *viscous* Matter upon the Bodies of the *Tench* is often serviceable to such *Carp* as have by Accident been wounded. It is found by Experience, that both these Kinds of *Fish* thrive much better in old *Ponds*, than those that have been newly made; and he gives this Reason for it, That in a *Pond* newly cut or dug, the *Water* is not all of one Piece, or partaking of the same Qualities, which it must have sufficient Time to draw from the Earth, and circulate through, or mix with every Part alike of the *Water*; for he holds it as a Maxim,

\* The late ingenious and honourable *Roger North*, Esq; of *Rougham*, in *Norfolk*, hath written a most excellent *Discourse* of *Fish* and *Fish-Ponds*, printed in the Year 1713; to which we refer for the *Breeding* and *Feeding* of *Fish*.



that *Fish* never thrive which have any Change of *Water* after they are 2 Years old, and therefore always stocks his *Ponds* with Store of the 2d Year. To experience this, he told me, that in one *Pond* he put in at the same Time *Carp*s of the old, marking those of the two last Age : Five Years afterwards he drew the *Pond*, and found that the young *Fish* of the 2d Year were much larger than any of the others ; which happened, as I suppose, for the same Reason that young *Plants* are more easily transplanted, and thrive much better, than elder *Plants* that have stood long enough in a Soil to be naturalized to it ; or that People, who have been bred up from their Infancy, and a long Time breathed their native Air, grow sickly upon changing it ; just so does the changing of *Fish* from one *Water* to another alter their Constitution. It is likewise observable, that a Plantation of *Trees* too near a *Pond* is apt to infect the *Water* with its falling *Leaves* ; but, on the other Hand, Shelter is necessary, and is much the best, as it consists of *Herbs* and *Plants*, which naturally grow in the *Waters*, such as *Water-Lillies*, *Pond Weeds*, and *Flags*, which feed and afford a great Number of *Insects* for the *Fish* to feed upon, and help to guard them from the too great Heats of the Sun ; but chiefly I am told these *Weeds* are useful to *Pike* and *Perch*, and that they are better fed *Fish*, and much larger in such *Ponds*, than where they have only a naked *Water*. The *Pike* being a

*Fish* of Prey, will admit of no *Fish* to abide with it but the *Perch*, and that only avoids the voracious Appetite of the *Pike*, by Means of the thorny *Fins* on its Back. In these *Ponds* however it is a common Practice to fling in a Parcel of *Roach* for the Food of the *Jacks*; and I knew a Gentleman, that thought it worth his while to stock his *Pike-Ponds* with *Frogs* for the same Use. These, as well as the *Carp* and *Tench*, may be fed with Blood and Bran mixed together, Raspings of Bread, or the Entrails of *Fowl* or *Sheep*; and if they are regularly used to be fed in this Way, at a constant Hour and Place of the *Pond*, they will in a short Time become undaunted, and feed before us, which is all I shall say at this Time relating to *Pond-Fish*.

## C H A P. XVI.

*Of the most curious Gardens in Europe, (especially in Britain) and what may be learnt particularly from them; with some New Remarks and Experiments relating to the Improvement of Fruit-Trees and Flowers.*

BESIDES the innocent Diversion which is found in a *Garden*, by cultivating many of the greatest Beauties of the Creation, Mankind may gain immediate Advantage in reaping the *Fruit* of his Labours. The Health of the Body is moreover maintained or encouraged,  
if



if we lend our helping Hand towards the propagating of *Vegetables*. A gentle Exercise in a Fresh Air, where the Mind is engaged with Variety of natural Objects, contributes to Content; and it is no new Observation, that the Trouble of the Mind wears and destroys the Constitution even of the most healthful Body. All Kinds of *Gardens* contribute to Health; but every one is not equally advantageous or profitable. There are *Gardens* of Grandeur and Recreation, such as those expensive ones at *Versailles*, *Marli* and *Trignon*, belonging to the King of *France*; and in *England*, the Royal *Gardens* at *Kensington*, and *Richmond*. The *Gardens* at *Kensington* have not indeed the Extent of those which I mention in *France*, nor had the Director of them the Happiness to make them All at one Time, but was content with giving now and then a Beauty as Occasion offered. The Irregularities which I remember were in the Ground, when he took the last Part of them in Hand, have particularly signalized his Judgment; so that we are led to an Imagination of the Beauties that would have appeared in them, if they had still been more irregular when he undertook them.

The Royal *Gardens* at *Hampton-Court*, are famous for the Variety of *Exotic Plants* brought from most Parts of the World, but more especially for the Healthful Condition of them, and exact Symmetry in the disposing them in their several Conservatories; and it is here that we have

Examples of *Orange-Trees* bearing Plenty of *Fruit*, in as great Perfection as we can desire, which surpasses any at *Versailles*; so that we may judge how much the Skill of a Director is necessary to contrive and manage in such a Case; for tho' the *Trees* at *Versailles* are extraordinary large, and in great Numbers, they were without *Fruit* when I was there; so that I cannot enough commend the Ingenuity of our *English* Artist.

The *Versailles Gardens*, as they are of vast Extent, and have cost immense Sums, it is needless to describe their Particulars; but in general we may say this of them, that their Order and Contrivance has been as well poetically as mathematically studied; each respective Part has a just Proportion with the History represented in the Statues and Water which it contains; so that we never observe too many, or too few Statues, or more or less Water than the Imagination can expect; and so near Nature is the artful Contrivance of these *Gardens*, that we are led with Expectation and Desire throughout the whole; but we must still observe, that in this Wonder of a *Garden* there is neither *Grass-work* nor *Gravel*, nor the beautiful Ornament of variegated *Hollies*, which is the Glory of *English Gardens*.

Was I to give a particular Description of our *English Gardens* for Pleasure, which the Curious, among our Nobility and Gentry, have brought to Order; a large Volume would not contain



contain it. Some are happy in their Situation for *Cascades* and *Fet d'eaux*; others have their Beauties in agreeable Prospects; and so likewise was I to describe particularly the *Gardens* in *France*, we should find them abound in natural Beauties, and only wanting of those Ornaments in which we exceed most other Parts of *Europe*, viz, *Grass*, *Gravel*, and Variety of hardy *Ever-Greens*. Again, the *Gardens* in *Holland* have very different Appearances and Modes from those in *England* and *France*; the *Holland Gardens* are not indeed without Water, but it is commonly such as is of no Use either for Water-works, or common Service to the *Plants*; for the Country is level, and the *Canal* Water commonly salt or brackish, so that I have often seen Boat-Loads of fresh Water brought from a great Distance; but the *Canals* which encompass and bound the *Gardens* have a very good Effect, being assisted with the Ornaments of *China*, and gilt Pots and Vases, with Statues, and Arbours or Cabinets of *Lattice* Work, which together afford an agreeable Prospect; but *Holland*, no more than *France*, possesses the Beauties of fine *Grass-Turf*, or *Gravel*, or the Ornament of our *English Ever-greens*; nor indeed is the Soil so natural to most *Herbs* of the *Kitchen-Garden*, as it is generally in *England*; which one may easily observe, by comparing the Produce of one with the other; but for bulbous *Roots*, we find it to produce Wonders, which has given me Occasion to consider  
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the Nature of that Earth more particularly: It is composed of fine *Sea Sand*, with a Mixture of *Turf* or *Peat-Earth*, which seems to be *two* Thirds of the former, and *one* of the latter; and the Benefit of this Kind of Soil in propagating Bulbous *Roots*, has made the *Hollanders* famous, especially in *Tulips*.

I have lately observed, that our *Heath-Ground*, which is most like the *Holland Soil*, yields very good *Saffron*, and even produces a better Crop than the *Chalky Soil* about *Saffron-Walden*. Upon the latter, an Acre of Ground, in its full Strength, brings about 12 Pounds of *Saffron* in a Season; but the *Saffron Roots* in the *Heath Ground* bring more *Flowers*, about one 6th Part. It is to be noted, that all the *Saffron Grounds* are subject to be destroyed by *Hares*, and therefore are inclosed with *Hurdles*: And again, the *second* or *third* Years of planting those *Roots* give the greatest Crops; for they must be separated or transplanted after the third Year's bearing, or else they produce little. But to proceed.

The profitable *Gardens* are of *three* Kinds; *first*, those cultivated for *Kitchen Uses*; *secondly*, the *Nurseries* for Improvement of *Timber*, *Fruit*, &c. and those which are disposed for the Use of *Physick*, and are the *Seminaries* and *Nurseries* of *Exotic Plants*.

The *first*, which are *Kitchen Gardens*, and exceed all the other *Gardens* in *Europe* for wholesome Produce, and Variety of *Herbs*, are those



those at the *Neat-Houses* near *Tothill-Fields*, *Westminster*, which abound in *Sallads*, early *Cucumers*, *Colliflowers*, *Melons*, *Winter Asparagus*, and almost every *Herb* fitting the *Table*; and I think there is no where so good a *School* for a *Kitchen Garden* as this *Place*; tho' *Battersea* affords the largest natural *Asparagus*, and the earliest *Cabbages*. Again, the *Gardens* about *Hammersmith* are as famous for *Strawberries*, *Rasberries*, *Currants*, *Goosberries*, and such like; and if early *Fruit* is our *Desire*, *North-End*, near the same *Place*, affords us *Cherries*, *Abricots*, and *Curiosities* of those *Kinds*, some *Months* before the natural *Season*. I could mention several particular *Gardens* about *London*, where I have found an *Excellency* in the *Gardeners* belonging to them; but as there are *Accidents* which happen every *Day*, that may occasion the *Removal* of the *Artists* from those *Places*, it will be of little *Use* to name them.

The *French*, in their *Kitchen-Gardens*, propagate *Mushrooms* in large *Quantities*; and, indeed, about *Paris*, the *Gardens* are chiefly employed in this *Way*, so that the *Markets* are plentifully stored with them at all *Seasons* of the *Year*; and I have often wondered, that none of our *English* *Gardeners* have yet taken up that *Business*, considering the *Profit* which would accrue to them from such an *Undertaking*: If they are still without *Knowledge* of the *Method* of raising them, they may be instructed

structed how, in our 2d Chapter. The other *French Kitchen Gardens*, contain little more than *Herbs* for Soup and Sallads, almost like those in *Holland*.

The next Degree of *Gardens* for Profit, are the Nurseries of *Forest-Timber* and *Fruit-Trees*; the chief of the first Sort are those about *Isleworth*, *Twickenham*, and *Brentford*, which abound in those necessary and useful Commodities; at which Places are annually raised, vast Numbers of every Kind of *Tree* which is proper for the Improvement of Land. Nor are the *Gardeners* of this Nation less curious in cultivating of *Fruit-Trees*; so that I esteem the Collections we have now in *England*, to exceed all the Nurseries in *Europe*, for profitable and useful Varieties.

We have also cultivated in *Espalier* the *Brussels Abricots* which affords a profitable Crop; but yet, in the most perfect *Gardens* which I have observed in *England*, I am surprised that I have not found any Variety of *Figs*, exceeding the old Set of the *Blue Fig*, the *Early White*, the *Long White*, and one other Kind. But in *France*, we meet with at least 50 Sorts of *Figs*, which afford as much Variety to the Taste, as the *Peaches* or *Pears* we have upon our Lists. There is one Observation I cannot omit in this Place, relating to the different Kinds of *Fruit*, which at present croud the Nurseries: Were we to take all the Sorts we have Names for, we should despise the



the greater Part; and, I believe, from what I have observed abroad, that there are no better *Fruits* than we have among us, because I find little Difference between the Lists of our Nurseries, and the *French* Lists that are sent over every Year from *Orleans*. For my own Part, I have remarked, that in *Devonshire*, *Herefordshire*, and some other Parts of *England*, the Seedling *Plants*, raised from the *Kernels* of *Pears*, *Apples*, &c. continually afford Varieties of *Fruit*, very different from what we gather from those *Plants* we had the *Seed* from. My curious Friend, *Samuel Reynardson*, Esq; of *Hillingdon*, near *Uxbridge*, has likewise raised several new Kinds of *Peaches* and *Grapes* from the *Stones* or *Kernels*; so that I see little Necessity for seeking out Varieties of *Fruits* in foreign Countries.

The *third* Sort of profitable *Garden* is the *Physic Garden*; where, besides the Collection of *Herbs* used in Medicine, we commonly find some Variety of such Exotic Rarities from the hotter Climates, as afford the Curious sufficient Matter of Admiration. The completest *Garden* of this Kind, I have yet seen, is that at *Amsterdam*; which, altho', it is not of great Extent, yet it affords the greatest Choice of valuable *Herbs* and *Plants*, agreeable to its Design, of any *Garden* in *Europe*. The Method of it is the Classing of *Plants* in several Beds appointed for that Purpose; upon which the famous Professors, *Drs. Comellin* and *Ruysh*,  
read

read to the Citizens *twice* every Week; the *first*, upon those which are *Exotic*, and the *latter* on the *Domestic*. The Governors of this *Garden* are the Chiefs of the City, who take Delight in making it a Nursery of such *Plants*, as the Trade of their Country will give them Leave to transport from the *East* to the *West Indies*. An Instance of which is, that in the Year 1714, when I was there, they raised a considerable Number of *Coffee Trees* from *Seeds*, which ripened at *Amsterdam* upon two *Plants*, that they first sent from *Africa* to *Batavia*, and from thence to *Holland*; from whence they transported them to *Surinam* and *Curasau*, supposing they might one Day bring forth profitable Crops that would yield Advantage to their Country; for these Places are so situate, that the Voyage to them is not a *Fourth* of *that* to the *East-Indies*, or a *Third* to the *African Coast*, where *Coffee* grows: And, if ever the *Dutch* should lose the Eastern *Coffee Trade*, or their *East Indian Plantations*, I expect that *Drug* will be chiefly brought to us from the *West-Indies*, where the *Hollanders* have planted it. It is to the *Amsterdam Physic Garden* I owe the greatest Part of that Collection of *Cu-ri-osi-ties* which I once gloried in; and to judge from what *Gardens* I have seen in *Europe* of this Order, I must do the *Amsterdam Garden* the Justice to own, that it exceeds all others in Variety of curious and useful *Plants*, from every Quarter of the World.

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The next to this, is the *Royal Garden* at *Paris*, where we may observe the Medicinal *Plants* ranged in exact Order, by the learned Dr. *Antonine de Jussieu*, the King's Professor of *Botany*. We find there likewise a fine Collection of *Exotic* Curiosities disposed after a regular Manner, and managed with excellent Skill; from whence I drew several *Plants* that had not been seen before in *England*.

The *Physic Garden* at *Leyden* is what we may admire for its good Order, and Variety of Foreign *Plants*, under the Direction of the late celebrated Dr. *Boerhaave*. It is here I have found the greatest Quantity of that extraordinary *Jessamine* of *Arabia*, whose *Flowers* excel all others in their Odour.

Among the Foreign *Physick Gardens*, I might yet mention that at *Pisa* in *Italy*, and the *Gardens* at *Florence* belonging to the Grand Duke of *Tuscany*; from whence, by his Royal Highness's Direction, I have received valuable Presents of choice *Plants*, rarely to be found in other *European Gardens*.

Our own regular *Physic Gardens* are not above three in Number; the best of which is that at *Chelsea*, belonging to the Company of Apothecaries; where we may observe a great Variety of such *Plants* as are useful and entertaining to the Curious, as well *Exotics* as *Domesticks*. The second is the *Physic Garden* at *Oxford*, improved through the Skill of the late learned Professor Mr. *Jacob Bobart*, who had  
the

the Management of it. The *third* is the *Physic Garden* at *Edinburgh*, which, according to the Account I have of it, is valuable for a good Collection of useful *Plants* in Medicine; but I doubt the Climate of that Country is hardly generous enough to encourage the Growth of such *Plants* as are Natives of the warmer Parts of the World.

To these we may add the curious Gardens of particular Persons, which are famous for their Varieties of valuable *Plants*; the chief of which in *England* are those at *Badminton*, whose Rarities were collected by that incomparable Lady the Dutchess of *Beaufort*. The Gardens belonging to *Samuel Reynardson*, Esq; at *Hillendon*, near *Uxbridge*; and the Collection at *Mitcham*, raised by Mr. *Du Bois*; and at *Cheame* in *Surrey*, by the Care and Skill of that excellent Florist the late reverend *Lumley Lloyd*, D. D. with which we must also mention that numerous Collection made by the ingenious Mr. *Fairchild* at *Hoxton*, superior to any I have yet named, both at Home and Abroad.

These are the chief of our *English* Gardens for Curiosity; not to mention my own Collection, which, with more than ten Years Pains and Expence, I got together, and is enough to support the Spirit of *Botany*; and to these every Lover of that Science ought to address himself, for his Satisfaction in the Knowledge of *Plants*.

But



But to make good the Title of this Chapter, I come now to speak of *Fruit-Trees*; and the first of all the *Orange*, which is now so much improved in its Culture, that it is possible to have a grafted *Tree* or *Plant* of this Kind in 5 or 6 Months, from the *Seed* or *Kernel*. I have observed, that the *Seed* of a *Lemon* will produce a *Plant* much more vigorous than that of an *Orange*, in the same Space of Time; and therefore, some nice Persons use *Lemon* Stocks rather than *Oranges*; but not more than 4 Months from the *Kernel*, “ cut the tender  
“ *Stems* of these horizontally, about half an  
“ Inch above the *Ear-Leaves*, and slit it down  
“ about half an Inch as in the Figure; and  
“ that your Design may be agreeable to the  
“ Laws of Nature, prepare *Cyons* of good  
“ bearing *Trees*, which are then tender in  
“ Shoot, and conformable to the Strength and  
“ Age of the Stock, so as to answer the Bigness of it; and pruning the lower End Wedge-wise, fix it in the prepared Stock, and tie it  
“ with Worsted, which takes little Room, and  
“ is subservient to Variety of Weather, by  
“ stretching or shrinking as the Air alters its  
“ Property; over this Binding, put a small  
“ Quantity of grafting Wax, and in a few  
“ Days the *Stock* and *Cyon* are joined, and become as much one Body as other *Grafts* and  
“ *Cyons* will do in 2 Months.” As this will do in *Orange-Trees*, I doubt not but every other Kind of *Fruit* may be as easily propagated, and

S then

then we should enjoy this Satisfaction, that where a *Bud* or *Graff*, in the common Case, is hard to be got, we could answer our End as well by a tender growing Shoot. But the Excellency of this Discovery seems to open a new Field of Knowledge, which may be greatly cultivated.

I shall next enquire into the common Complaint of those Gentlemen, who wait with Impatience for the *bearing* of the *Fruit-Trees* they have planted; and for that Reason I have contrived a Method, which I think will be satisfactory to them; and whereby there is not any Month in the Year, in which they may not plant their *Gardens*, but especially their Walls, with any *Fruits* they desire; by which Means they will not only gain 2 or 3 Year's Time, but may even bring their *Trees* into their *Gardens* with *Fruit* upon them, and so be satisfied they possess the Varieties they desire.

To do this, I would advise them to provide a large Number of Boxes, whose Frame and Sides may be taken to Pieces at Pleasure, each of these Boxes to measure 18 Inches over, and as many in Depth; in these let a Set of *Fruit-Trees* be planted, of the best Kinds, and trained up in the same that we use to those *Trees* which are planted against Walls, giving them their regular Pruning from Time to Time, and directing their *Branches* and *Twigs* in the Posture they ought to lie upon *Espaliers* made of *Arbor-poles*: When these *Trees* are brought



brought to *bear*, we may transport them to any Distance with their Cases, without injuring them; and be it what Season it will, they may be set into the Ground at once, with their whole Clump of Earth, and without receiving any Injury. In this Operation, Care must be used in taking off the Cases, that the Clump of Earth is not cracked or broken, lest the Air get in; the Bottom-Board therefore must be interred with the *Tree*, and the remaining Parts of the Cases may serve again.

To conclude, I recommend the raising of all Sorts of *Flowers* from *Seeds*; and, I think, there can be no greater Motive to encourage our Gardeners to this Undertaking, than directing them to Dr. *Lloyd's* of *Cheame*, Mr. *Dunklyn's* at *Clapham*, Mr. *Hunt's* at *Putney*, and Mr. *Fairchild's*, where they may observe wonderful Collections of *Flowers*, viz. *Ranunculus*, *Bulbous Iris*, &c. lately raised from Seminaries discreetly made by those Artists.

*Explanation of the Plates relating to this Chap.*

Fig. I. *A Cyon cut from a tender Shoot of the Orange-Tree, which is the youngest Sprout that could be cut from thence.*

Fig. II. *A young Lemon Plant in its 1st Growth, when the Ear-Leaves are upon it, agreeable to the Age, Strength, and Bigness of the Graff.*

Fig. III. *A Fruit-Tree planted in a Case, and trained up in Espalier, so that it may be planted against a Wall at any Season, even in Flower*

*A Philosophical Account of the  
or Fruit, on the Situation we desire, without in-  
juring the Tree ; designed for the Advantage of  
such as cannot plant their Gardens at their own  
Time. In this Figure the Case is so contrived,  
that it may upon this Occasion be taken to pieces,  
and returned to the Place it came from, without  
doing Hurt to the Plant.*

## C H A P. XVII.

*Of VINES ; the best Method of Pruning them ;  
with some proper Hints for such as delight in  
raising forward FRUITS.*

**T**HE Opportunities I have lately had of making Observations on the Management of *Vines* in *France*, give me Occasion to mention some Improvements which are pleasant and profitable, and may greatly forward the Ripening of that delicious *Fruit* in *England*.

It is observable, that every *Vineyard* in *France* chiefly depends on the *Fruit* produced by *Annual Layers* ; for the *Fruits* they bear are much larger, and ripe earlier, than what we find growing upon the *Old Stocks*, whose greatest Use is to yield *Branches* for the *Layers* of another Year. This leads us to judge of the Method of managing our *Wall Vines*, and directs us to preserve the young *Wood* for the sake of large and good *Fruit*. It is therefore improper to build an high *Wall* for *Vines*, because all *Old Wood* should be taken away, and the most vigorous of young *Shoots* left



left at due Lengths for a Crop; and in this Case we must have regard to the Substance of the Wood we preserve: A *Branch*, for Example, whose Diameter is about  $\frac{1}{2}$  an Inch, may be left a Yard long; a *Branch* of one 3d of an Inch in Thickness, about two Foot; and so in Proportion; and at the same Time, in convenient Places, 2 or 3 *Buds* must be kept to supply *Branches* for the following Year.

I have likewise farther considered the Method of Raising *Vines*; and among many Experiments I made, I found one, which, I think, will be of extraordinary Use, by giving us that Satisfaction which we have long wanted, of planting Sets, or Cuttings of *Vines*, all the Summer Season; so that where we are sure of a *Grape* we like, we may at any Time propagate as many of that Sort as we please.

In *May*, which is the Month when those Gardeners who have pruned unskilfully, are obliged to dismember their *Vines* of the crouding *Branches*, then beginning to bud out, we may plant every *Shoot* they pull off with the same Success that we are used to make Nurseries of them in *November*, *December*, or any of the Winter Months. In this Practice we must cover the Part that is to be interred with common soft Soap; and from a *Shoot* thus managed, we are sure of a strong *Plant* before the colder Seasons reach us, as I have experienced. By this Method we learn *two* Things; first, that Soap is of excellent Use to the Im-

provement of the Growth of *Vines*; and, secondly, that we may gain a Year by this *new* Discovery: And from the whole I gather thus much, that Soap is the best Manure for *Vines* in general.

I next come to describe those Methods now in Use for producing of forward *Fruits*, by Means of artificial Heats; such as *Coal* or *Wood-Fires*, or *Horse-litter*. The first is by building Ovens at certain Distances at the Back of the Walls, and keeping them continually warm, from *January*, till the Sun's Power is sufficient of itself to maintain the Growth of the *Plants* fixed against such Walls, as it is now practised at his Grace the Duke of *Rutland's*, at *Belvoir-Castle*, whereby the latest Kinds of *Grapes* are commonly ripened about *July*, or *August*; but in this Method we must likewise take Notice, that during the cold Season, when these *Fruits* are forced to shoot unseasonably, the *Plants* must be covered with Glasses, to prevent the Injuries they might receive from Frosts.

But the New Method to force *Cherries*, *Abricots*, and some other Kinds of *Fruit*, I take to be much the cheaper Way; which is, by building a Pale 5 or 6 Foot high, composed of Inch-Deal-Boards closely jointed, on the South of which nail up your *Trees*; and about *December* lay a Coat of Horse-Dung to the Back, about 3 Foot thick at the Base, sloping, to about a Foot and  $\frac{1}{2}$  at the Top, which for  
about



about 6 Weeks strikes a Warmth thro' the Boards, so agreeable to Vegetation, that the *Plants* blossom and dispose themselves to bear *Fruit* in great Abundance. Here I must observe, that when the Weather is moderate, you must give them what Air you can, by properly opening the Glasses which stand before them; and when the Litter at the Back of the Pale has lost its Heat, renew it from Time to Time, till the Season becomes natural to the Growth of *Trees*.

Having now given my Readers what I at first proposed, *viz. A Philosophical Account of some Works of Nature, in the Mineral, Vegetable, and Animal Parts of the Creation, in as many Instances as Time would admit for the necessary Experiments, &c.* I am next to inform them, that if this Attempt prove satisfactory, a *Scheme* may be carried on so useful to Mankind, as, by Degrees, may form a *General and Compleat Body of Experimental-Natural-Philosophy*.

F I N I S.









# A P P E N D I X

TO THIS

## S E C O N D E D I T I O N .

*Observations on the FLEA and LOUSE ;*  
*By the late ingenious Dr. HOOKE,*  
F. R. S.



THE Strength and Beauty of the first of these Creatures, the Flea, had it no other Relation at all to Man, would deserve a Description.

For its Strength, the Microscope is able to make no greater Discoveries of it than the naked Eye ; but only the curious Contrivance of its Legs and Joints; for the exerting that Strength, is very plainly manifested, such as no other Creature, I have yet observed, has any Thing like it ; for the Joints of it are so adapted, that he can, as it were, fold them short one within another, and suddenly stretch, or spring them out to their whole Length ; that is, of the Fore-Legs, the Part A of Plate XXIX. lies within B, and B within C parallel to, or Side by Side each other ; but the Parts of the two next, lie quite contrary ; that is, D without E, and E without F, but parallel also ; but the Parts of the hinder Legs G, H and I, bend one within another, like the Parts of a double-

double-jointed Rule, or like the Foot, Leg, and Thigh of a Man. These six Legs he clitches up all together, and when he leaps, springs them all out, and thereby exerts his whole Strength at once.

But, as for the Beauty of it, the Microscope manifests it to be all over adorned with a curious polished Suit of sable Armour, neatly jointed, and beset with Multitudes of sharp Pins, shaped almost like Porcupines Quills, or bright conical Steel-Bodkins; the Head is on either Side beautified with a quick and round black Eye, K, behind each of which also appears a small Cavity, L, in which he seems to move to and fro a certain thin Film beset with many small transparent Hairs, which probably may be his Ears; in the Forepart of his Head, between the two Fore-Legs, he has two small long jointed Feelers, or rather Smellers, M M, which have four Joints, and are hairy, like those of several other Creatures; between these, it has a small *Proboscis*, or *Probe*, N N O, that seems to consist of a Tube, N N, and a Tongue or Sucker, O, which I have perceived him to slip in and out. Besides these, it has two Chaps or Biters, P P, which are somewhat like those of an Ant, but I could not perceive them toothed; these were shaped very like the Blades of a Pair of round-topped Scissars, and were opened and shut just after the same Manner; with these Instruments does this little busy Creature bite and pierce the Skin, and suck out the



the Blood of Animals, leaving the Skin inflamed with a small round red Spot. These Parts are very difficult to be discovered ; because, for the most Part, they lie covered between the Fore-Legs. There are many other Particulars, which, being more obvious, and affording no great Matter of Information, I shall pass by, and refer the Reader to the Figure.

*Of the LOUSE.*

**T**HIS is a Creature so officious, that it will be known to every one at one Time or other ; so busy, and so impudent, that it will be intruding itself in every one's Company ; and so proud and aspiring withal, that it fears not to trample on the best, and affects nothing so much as a Crown ; feeds and lives very high, and that makes it so saucy, as to pull any one by the Ears that comes in his Way, and will never be quiet till it has drawn Blood : It is troubled at nothing so much as at a Man that scratches his Head, as knowing that Man is plotting and contriving some Mischief against it, and that makes it oftentimes sculk into some meaner and lower Place, and run behind a Man's Back, tho' it go very much against the Hair ; which ill Conditions of it having made it better known than trusted, would exempt me from making any further Description of it, did not my faithful *Mercury*, my Microscope, bring me other Information of it. For it has  
discovered

discovered to me, by Means of a very bright Light cast on it, that it is a Creature of a very odd Shape. It has a Head shaped like that expressed in the Plate marked with A which seems almost conical, but is a little flattened on the upper and under Sides; at the biggest Part of which, on either Side behind the Head (as it were, being the Place where other Creatures Ears stand) are placed its two black shining goggle Eyes, B B, looking backwards and fenced round with several small *Cilia* or Hairs that encompass it, so that it seems this Creature has no very good Foresight: It does not seem to have any Eye-Lids; and, therefore, perhaps its Eyes were so placed, that it might the better cleanse them with its Fore-Legs; and, perhaps, this may be the Reason why they so much avoid and run from the Light behind them; for being made to live in the shady and dark Recesses of the Hair; and thence, probably, their Eyes having a great Aperture, the open and clear Light, especially that of the Sun, must needs very much offend them. To secure these Eyes from receiving any Injury from the Hairs through which it passes, it has two Horns that grow before it, in the Place where one would have thought the Eyes should be; each of these, C C, hath four Joints, which are fringed, as it were, with small Bristles, from which to the Tip of its Snout, D, the Head seems very round and tapering, ending in a very sharp Nose, D, which seems to have



have a small Hole, and to be the Passage thro' which he sucks the Blood. Now, whereas, if it be placed on its Back, with its Belly upwards, as it is in the Plate, it seems in several Positions to have a Resemblance of Chaps, or Jaws, as is represented in the Plate by E E, yet in other Postures those dark Strokes disappear; and having kept several of them in a Box for two or three Days, so that for all that Time they had nothing to feed on, I found, upon letting one creep on my Hand, it immediately fell to sucking, and did neither seem to thrust its Nose very deep into the Skin, or open any Kind of Mouth, but I could plainly perceive a small Current of Blood, which came directly from its Snout, and past into its Belly; and about A. there seemed a Contrivance, somewhat resembling a Pump, Pair of Bellows, or Heart; for by a swift *Systole* and *Diaſtole* the Blood seemed drawn from the Nose, and forced into the Body. It did not seem at all, though I viewed it a good while as it was sucking, to thrust more of its Nose into the Skin than the very Snout D, nor did it cause the least discernible Pain, and yet the Blood seemed to run through its Head very quick and freely, so that it seems there is no Part of the Skin but the Blood is dispersed into; nay, even into the *Cuticula*; for had it thrust its whole Nose in from D to C C, it would not have amounted to the supposed Thickness of that *Tegument*, the Length of the Nose being not more than  
a three

a three hundredth Part of an Inch. It has six Legs, covered with a very transparent Shell and jointed exactly like a Crab's, or Lobster's; each Leg is divided into six Parts by these Joints, and those have here and there several small Hairs; and at the End of each Leg it has two Claws, very properly adapted for its peculiar Use, being thereby enabled to walk very securely both on the Skin and Hair: And indeed, this Contrivance of the Feet is very curious, and could not be made more commodiously and compendiously, for performing both these requisite Motions, of walking and climbing up the Hair of a Man's Head, than it is; for by having the lesser Claw (a) set so much short of the bigger (b) when it walks on the Skin the shorter touches not, and then the Feet are the same with those of a Mite, and several other small Insects; but by Means of the small Joints of the longer Claw it can bend it round, and so with both Claws take hold of a Hair, in the Manner represented in the Plate, the long transparent Cylinder, F F F, being a Man's Hair held by it.

The Thorax seemed cased with another Kind of Substance than the Belly; namely, with a thin transparent horny Substance, which upon the Fastening of the Creature did not grow flaccid; through this I could plainly see the Blood, sucked from my Hand, to be variously distributed, and moved to and fro; and about G there seemed a pretty big white Substance, which seemed



seemed to be moved within its Thorax ; besides, there appeared very many small Milk-white Vessels, which crost over the Breast between the Legs, out of which, on either Side, were many small Branchings ; these seemed to be the Veins and Arteries, for that which is analogous to Blood in all Insects is Milk-white.

The Belly is covered with a transparent Substance likewise, but more resembling a Skin than a Shell ; for it is grained all over the Belly just like the Skin in the Palms of a Man's Hand, and when the Belly is empty, grows very flaccid and wrinkled ; at the upper End of this is placed the Stomach, H H, and perhaps also the white Spot, I I ; may be the Liver or Pancreas, which, by the peristaltick Motion of the Guts, is a little moved to and fro, not with a Systole and Diastole, but rather with a thronging or jussling Motion. Viewing one of these Creatures, after it had fasted two Days, all the hinder Part was lank and flaccid, and the white Spot, I I, hardly moved, most of the white Branches disappeared, and most also of the Redness or sucked Blood in the Guts, the Peristaltick Motion of which was scarce discernible ; but upon the suffering it to suck, it presently filled the Skin of the Belly, and of the six scolloped Embossments on either Side, as full as it could be stuffed ; the Stomach and Guts were as full as they could hold ; the Peristaltick Motion of the Guts grew quick,  
and

and the juttling Motion of II accordingly; Multitudes of Milk-white Vessels seemed quickly filled, and turgid, which were perhaps the Veins and Arteries, and the Creature was so greedy, that though it could not contain more, yet it continued sucking as fast as ever, and as fast emptying itself behind: The Digestion of this Creature must needs be very quick, for though I perceived the Blood thicker and blacker when sucked, yet, when in the Guts, it was of a very lovely ruby Colour, and that Part of it, which was digested into the Veins, seemed white; whence it appears, that a further Digestion of Blood may make it Milk, at least of a resembling Colour: What else is observable in the Figure of this Creature, may be seen in the Plate.

As these Vermin are natural to the Bodies of the human Species, so likewise, most Birds of different Kinds, some Sorts of Fish, and many Kinds of Quadrupedes have their particular Sorts of Fleas, and Lice, proper and peculiar to themselves, and manifestly differing from each other. Seignior *Redi* having delineated some of these, I think it will not be foreign to the Subject, to relate the Discoveries (he tells us) he made, by the Advantage of a great many Experiments.

In the Hawk, (says he) I have observed 3 distinct Sorts of Fleas, and as many in the Turkey Hen; in the Wild-duck four; in the Swan, Wild-goose, Kestrel, and Plover, two: Yet



Yet it must be allowed that there is a Sort of Birds that have either the same Sorts of Fleas, or some that are very like them. The Golden Eagle, and the Bird by the *Italians* called *Vaccaio* from its keeping Company with Cows, as well as the Kestrel, have very large Ones: Which last named Bird hath also another Sort of Fleas, no ways differing in Shape from those of the Raven, but of another Colour; and the Raven others, very like the lesser Sort of Lice found upon the *Egret*. Some of the Bustard's Fleas, if viewed at a Distance, very much resemble those found upon the *Egret*. On the Wood-pecker and Chaffinch, I have seen Fleas resembling those of the Starling, and on the Wild-duck of the larger Kind, much the same Sort of Fleas with those of the Wild-goose. In the Feathers of a Crane are to be found Nests of white Lice, marked, as it were, with *Arabick* or *Algebraick* Characters. Farther, it is remarkable, that the Bigness of each Bird's Fleas bears no adequate Proportion to the Bigness of the Birds they are found upon; but amongst the larger Kind of Birds may be found a lesser and larger Sort of Fleas of a different Kind; and I remember that I have seen Fleas upon a Black-bird as large as those found upon a Swan.

If you view Fleas when upon their Feet, there is not the least Appearance of a Mouth to be discovered; but if you turn them upon their Backs, you may discern the Situation of their Mouth placed on the under Side of the Pro-

boscis or Trunk, in the Form of a Pair of Pinchers, much resembling that of the Wood-louse. In a Word, there is such a wonderful Variety of Fleas of distinct Sorts, so strangely different one from another, that I thought it much better to exhibit them drawn upon Copper-Plates, than to give the Reader a long and tedious Description of them. As to their Colour, it is generally the same, or very near that of the Feathers of the Birds on which they are found. It is true, I am of Opinion (which Experience countenanceth) that Fleas when they are first bred out of Nits are white ; but as they grow bigger, by Degrees assume other Colours, yet so that preserving the Transparency of their Bodies, by the Help of a Microscope, the Motion of their Entrails, and Circulation of their Juices may be very plainly discerned.







*Observations made by an English Gentleman  
upon the Husbandry of Flanders.*

AFTER I had seen the greatest Part of *Flanders*, and diligently examined the Nature and Condition of the Soil, which in some Parts I conceived to be very rich, (in respect of the goodly Barley and Wheat which I saw it produced, and the excellent Pasture Grounds,) at my Return to *Ghent*, I asked a Merchant, which was the richest Part of *Flanders*: He told me, the Land of *Wasse*, which lay between *Ghent* and *Antwerp*; the which I wondered at, and replied, that in my Opinion it was the poorest sandy Land in all the Country, and that it carried nothing but Rye, Buck-Wheat, and Oats; and in the Highways that were not ploughed, the Ground, of its own Nature, produced Heath. He told me again, that it was the best Ground for *Flax*, which was called the Wealth of *Flanders*. I asked him, what an Acre of *Flax* might be worth. He answered me, that a Gamett, which was their Acre, might be worth forty or fifty Pounds; and much to the same Purpose I was afterwards informed by others. Upon this, I desired to know the Difference between a Gamett and an *English* Acre; which having learned, I made an *English* Rod; and, the better to inform myself what an Acre might be worth,

worth, the next Year I bought an indifferent Rod of *Flax* when it was ripe, which I caused to be pulled, watered, and dressed by itself, and then weighed, that by that Proportion I might come to know the Value of an *English* Acre; which by that Trial came to 36 *l.* 14 *s.* 6 *d.* I found, that after their *Flax* they ordinarily sowed *Turnips*, with which the Country People fed both themselves and their Kine, which afterwards fed them with Plenty of Milk. I found also, that when they laid down that Ground from ploughing, they sowed it with a Clover-grass Seed, which grew so rank and great as I never saw any Grass do in our best Meadows in *England*. Upon the understanding of all this, I was convinced in my Judgment, and found the Merchant had Reason, who told me it was the richest Part in *Flanders*; and, having a great Quantity of such natured Ground of my own in *England*, I sent over Clover-grass Seed, and caused *Flax* to be sowed, to make a Trial how it would do there, of which I have had such Account as makes me admire the wonderful Blessing of Almighty God, from whose Bounty and Goodness all the Fruits of the Earth do proceed.

I have found by my own Experience, that there is no Ground of a Mold so barren, but it may, (by the Labour and Industry of Man) be made to produce all Sorts of Grain and Seeds, and all Sorts of *Plants* and *Trees*, which are necessary for the Use of Man, according to the several Climates wherein Men live. I would therefore



therefore have those younger Brothers, (for whose Sake I principally intend my Discourse,) first, to take a Farm containing 500 Acres of the most barren and heathy Land they can find, so as it consisteth of a sandy or hazel Mold, and lies either dry of its own Nature, or so as by Art the Water may be drained from it: This Land (which may be had at an easy Rent) must be first *Devonshired*: But because there are several Sorts of Husbandry which are to be used to improve such Land, according to the Quality or Conveniency of the Place where such Land is seated, I will advise every younger Brother to begin with a little, until he hath found by his own Experience, what Husbandry suiteth best with the Condition and Quality of his Ground; that is, what Husbandry is cheapest and most profitable; and then he may increase his Quantity as he sees Cause.

The little Quantity of Ground which I shall set down for Example's Sake, to begin withal, shall be twenty five Acres, which may produce as great Benefit as his eldest Brother's Estate of 1000 Pounds a Year; and if that prove right, he will be encouraged to proceed in a larger Proportion, whereby he may quickly prove a better Man in Estate than his elder Brother; who, perhaps, like an idle Drone, contented with what his Father left him, lives at his Pleasure and Ease, whilst he by his Industry gathers his Profit out of the Bowels of the Earth, which God gave unto Man to that End:

For *vigilantibus, non dormientibus, dat Deus Incrementum*. But because there are several Ways to improve Land, and that such heathy and barren Land is not worth the sowing till it be improved, I will first set down such several Ways as I have observed for the Purpose, and so leave it to those that are to reap the Benefit, to make Choice of that they like best, and afterwards set down, as near as I can, the Charge that is to be laid out to raise so great a Profit, and then the particular yearly Gain that (I conceive) by God's Blessing may arise thereby.

Your most common Way of improving Land is by Dung, whereof they will reap the greatest Profit that are seated near some Market Town, where ordinarily you may buy a great Quantity from the Inns, at 1 s. the Load. But because every Man cannot be so seated, I will teach you an easy Way to raise Dung, if you can keep but three or 400 Sheep, in Manner following: You must house them every Night, and in the Summer at Noon; but you must first lay 3 or 4 Inches of Sand at the Bottom of the Floor, and thereon lodge your Sheep for a Night or two, till their Dung and Piss be trod into the Sand, and then continually lay on more Sand, and let it be used in the same Manner, by which Means three or four hundred Sheep will raise 1000 Load of Dung a Year, which will richly manure fifty Acres for *Flax*. If you have any Ponds, the Earth of them being cast, a Year before you use it, will be excellent  
good



good to mingle with the Dung, and so laying about 12 Load upon an Acre to mix with the Ashes after the Ground is baked and burnt, it will produce you two or three plentiful Crops of whatever Seed you shall think fit to sow. But where there cannot be Dung enough had, I will teach you another Way to improve the Land, where Lime is to be had, which is thus: When you *Devonshire* your Ground, divide the Hills into eightscore for every *Rue*, viz. a Hill to a Rod, and put into every Hill a Peck of Lime, if you can, before it be flaked, and when it is flaked in the Midst of the Hills, which it will be after the first Rain, then mingle the Lime and Ashes together, and spread it upon the Land. It is an usual Thing to lay 4 or 5 Loads of Lime upon an Acre, where the Land is not *Devonshired*: But I have seen the other Way, which is much the cheaper, does extream well for 2 or 3 Crops. If there be Marle in the Ground, I will teach you another Way, but not according to the ordinary Way used in *Suffex*, where they lay 250 or 340 Loads upon an Acre, but in a cheaper Manner, which is thus: Lay 40 Load of Marle in the Summer upon an Acre of heathy and barren Ground, and presently spread it, and let it lie all the Winter until the *March* following, by which Time it will be washed into the Ground; then bake and burn it, and sow the Land. By this Husbandry I have seen Ground (that was all Heath as high as one's

Knee) have 2 or 3 Crops of good Corn, and afterwards bring forth as good Clover-Grafs as ever I saw grow in *England*.

The next Thing I will lay down, shall be the Charge of ploughing and sowing.

The *Devonshiring* 25 Acres will cost 25 *l*.

The Lime a Load an Acre at 40 Bushels to the Load, and 15 *s*. a Load, 18 *l*. 15 *s*.

The ploughing and harrowing of 25 Acres at 6 *s*. an Acre, 7 *l*.

Four Bushels of *Flax* Seed to sow an Acre at 6 *s*. a Bushel, for 25 Acres, 30 *l*.

Weeding, pulling, swingling the *Flax*, and all other Charges, valued at 3 *l*. an Acre, 75 *l*.

The whole Charge amounts to 156 *l*. 5 *s*.

The Interest of 156 *l*. 5 *s*. cometh to yearly about 12 *l*. 5 *s*.

And the Rent of the Land at 2 *s*. an Acre, 2 *l*. 10 *s*.

So the Whole amounts to 14 *l*. 15 *s*.

Five and twenty Acres valued according to the Proportion which an indifferent Rod of *Flax* did bear, which was 5 Pound and a Quarter from the Brake at 8 *s*. the Pound, being the ordinary Price in *Ghent*-Market, comes to 33 *l*. 12 *s*. *English* an Acre, which for 25 Acres is 840 *l*.

The Seed of twenty-five Acres, valued as the same Rod did bear, which was five Pound, cometh to 12 Bushels and a half an Acre, which at 5 *s*. the Bushel, is 3 *l*. 2 *s*. 6 *d*. the Acre:



Acre: For 25 Acres it is 78 *l.* 2 *s.* 6 *d.* The Whole is 918 *l.* 2 *s.* 6 *d.*

These 25 Acres are to be sowed with *Flax*, in *March*, *April*, or *May*, and will be ready to pull in the Beginning of *August* following, and then you may sow for Turnips, which will be ripe in *October* following, and may be pulled from that Time to the End of *December*. The Turnips about *Ghent* in *Flanders* (besides what the People eat) are much employed to feed their Kine; and I have a Receipt in my Book, (which I had from People of great Credit,) with which they feed lean Kine with Turnips, Grains, and Washings of Barrels of Beer together, that yielded them as much Milk in a Year, as would have cost them 60 *l.* *English*, and yet they valued their whole Charge in keeping them not to be above 5 *l.* a Cow, and the Turnips were far the greatest Charge. But because this Rule seemeth to me to be a greater Gain than our Kine will ever yield in *England* (for which there can be no other Reason, but that Milk is sold at a dearer Rate in *Ghent* than it is in *England*) I have not set down the Charge of ploughing and sowing Turnips (which is but a small Matter,) nor the Charge of the Stock of the Kine, because I have reduced them to half the Profit which they make of them in *Ghent*; but I do verily believe, that 25 Acres of good Turnips will keep 15 Kine, and the Profit of 15 Kine to be worth yearly 15 *l.* for each Cow; and suppose that besides the Turnips they will eat,

eat, there will be as many sold out of the 25 Acres as will pay for the Grains, and other Charges belonging unto them, and so by this Account those 15 Kine will yearly profit 225 *l.*

Which being added unto the 903 *l.* 7 *s.* 6 *d.* on the other Side for the Profit of *Flax*, the Whole makes up 1128 *l.* 7 *s.* 6.

This Profit of *Flax* and Turnips ariseth from the 25 Acres in 8 or 9 Months, which is from the Beginning of *April* to the latter End of *December*, and then you have three compleat Months left untill *April* again to stir up the Ground; and then sow it with Oats or Barley, together with the Seeds of a Clover-Grass, whereof 9 Pound will sow an Acre, and so let that Ground rest, and still plough up fresh Ground in the same Manner, and lay it down as before, with Clover-Grass; and when you have ploughed up all the Heathy Land, you may begin with that again which was first layed down with Clover-Grass. This Clover-Grass will make your Land yield you as much Profit as the best Land in *England*, both for Hay and Grass; and when you have enough of that Grass, to keep you a convenient Stock to plough up your own Ground, you may increase your Quantity of Tillage, and sow some Corn for your own Provision, whereby you will have Straw to keep more Cattle, and thereby raise more Dung. But if you find your Profit rise out of your *Flax* and Turnips but near to what you may by this Relation expect, it will not be worth your Labour



bour to sow any more Corn than for your own necessary Use, but to employ your Labour as much as you can in the other, which will yield you six Times the Profit of the best Corn you can sow.

To bring the Cattle to eat Turnips, you must breed them up from their Dams by Hand, as they do all manner of Cattle in *Flanders*; as Horses, Beasts, and Sheep, all which they feed many Times with Turnips, Carrots and Parsnips; and I have seen a Horse that was eating of Grass, as soon as Carrots, cut in small Pieces, were laid before him, forsake the Grass, and eat them like a Hog: And all *Mechlin* in *Flanders* (where they have as rich Pastures as any be in *England*) they feed their fat Sheep principally with Carrots in the Winter, and they give both them and Turnips to their fat Beasts in *Ghent*.

Their Horses are very large and serviceable, and, for the the most Part, extraordinary broad-buttocked; the which whether I could attribute it to the Kind of the Horses, or the Breeding them by Hand, and so making them eat Roots or any Thing, or to both: They give them little Hay; but Straw, and Oats, and Bean-Stalks, and Beans chopped together: They let their Mares go to Cart and Plough, till they are ready to foal under the Cart, and presently suckle the Colt, and make it eat Butter-Milk, either with Bran, or Grains warmed, whilst the Mare is at Plough or Cart; and as soon as the Mare is come Home from work, they let the Colt suck presently;

presently ; and say it takes no Hurt. I believe that an handsome *English* Horse and these Kind of Mares, would breed most useful Horses.

They have in *Flanders* a Kind of Sheep between a Place called *Vecue* and *Dixmeire*, that ordinarily bring 5 or 6 Lambs a-piece, and by feeding the Ewes with Roots, and bringing the Lambs to eat any Thing, they will all come to good : The like, no Question, we may do in *England*, if we get the same Breed of Sheep ; and that it is the Kind of their Horses and of their Sheep, that makes exceed ours, I do the rather believe, because their Beasts in *Flanders* ( even in the richest Parts ) are not generally compared ( neither in Bigness nor Handsomeness ) to our Beasts of *England* ; and why should they not exceed our Beasts, as well as our Horses, if it were not the Kind, and not the Feed ? The like is in the Capons : For the Kind of a *Bruges* Capon is as big as two *English* Capons ; yet here at *Ghent* their Veal is cried up beyond any Part of the Country, which if there be not as good in *England*, you may have it as good by feeding it thus : Their Calves, being presently taken from the Cow, and suckled by Hand, as soon as the Cow's Milk is good, they feed them with nothing but Butter-Milk, until they can eat Turnips and Carrots mashed, as they feed their Kine, or until a Fortnight or 3 Weeks before they kill them ( which they do seldom till they be a Quarter old ) and then for that Fortnight or 3 Weeks, they give them as  
much



much New-Milk as they will drink thrice a Day, and that makes them fat ; and indeed it is as good, and as white as I have seen any.

Their Hogs be likewise here very large and fat ; which are kept up and fed most with Carrots and some Turnips, and fatted altogether with Buck-Wheat. There are very few Warrens in their Country ; but Abundance of tame Coneys, so big and fat, as I never saw any in *England*: They are fed with Turnips, but most with Carrots, and now and then some Bran, or a few Oats. I do believe that a Warren of some 3 or 4 Acres well fenced in, (if the Coneys be fed in this Manner) would breed enough to keep a very good House. Most of the Pigeons of this Country are likewise tame, and they are fed most with Buck-Wheat, and sometimes with *Flax*-Seed, which makes them lusty, and breed a-pace.

This Buck-Wheat they use much in their Beer, which is commonly very good ; and I have heard an *English* Doctor of good Repute affirm, that Buck-Wheat is as wholesome a Grain as any grows in *England* ; and that they make fine Puddings of it in *Italy* ; and, to confirm this Opinion, he shewed me an Author of great Repute amongst the Physicians. They also feed their Capons here with Buck-Wheat and Butter-Milk. The next necessary Thing to a House is, a good Kitchen-Garden and Orchard, which may, at all Times and Seasons, yield you all Manner of Sallads, Turnips, Carrots, Parsnips,

Parfnips, Scarots, Beetranees, Savayon, Beans, Pease, Artichokes, Asparagus, and the like.

There is another pretty Commodity to be raised with a very small Charge; which is, out of a Bee-Garden, of which there are many in the New-Forest in *England*, which are worth 40 or 50 Pounds a Year, although the Honey that is gathered from Heath, is not reputed so good as that which is gathered from better Flowers. The rest of your Land, besides what you plough, will yield you a considerable Profit, in keeping the Sheep and young Beasts: So with the Addition of these Commodities unto the Main (which are the *Flax* and Turnips,) a younger Brother may both live, and quickly grow rich; so as he manageth the Affairs of this World with one Hand, and lay hold of the Providence of God with the other,

But when God hath sent you the Fruits of the Earth in a plentiful Manner, you must have a care that the *English* Proverb be not fulfilled, which is commonly used when Meat is ill dressed, *viz. Though God sends Meat, yet the Devil sends Cooks.* So let the *Flax* be never so good, if you have not those that know when it is fit to pull, you shall lose infinitely in the Weight of the *Flax*, (from whence arises the greatest Profit) if you let it stand till the Seed is ripe, or in the watering your *Flax*; for if you have not those that know when it is fit to take it out, or if you let it lie too long in the Water, it will rot;  
or



or if you take it out too soon, it will not break; or in the letting it lie too long abroad a-drying, or without turning it often after it is taken out of the Water: If any of these Mischiefs happen, it is enough to discourage a young Beginner: Therefore let me advise you, first to take some experienced Man and Woman out of *Flanders*, where all Things concerning *Flax* are as common, in course of Husbandry, as sowing and threshing of Corn in *England*.

Your *Flax* being made fit for Sale, you must carry a Pattern of it to *London*, where if you cannot sell it to your Content, you must enquire out some Merchant to vent it for you beyond Sea, where the greatest Trade of making Cloth is, as at *Harlem* in *Holland*, or elsewhere: For it is not prohibited to be transported beyond Sea as Corn is: Or it may be in Time, when you are grown before-hand with the World, you may think fit to set up a Manufactory of Cloth your self, and then it will vent at *London*, as well as any Commodity the Kingdom will afford. But howsoever, I would have you keep as much *Flax* as will set all the poor People about you at Work to spin into Thread, and by that you may be both a good Gainer, and do a charitable Act, for which God will bless your Labours the better, and you shall be sure to have ready Money at *London* for the Thread, it being as vendible there as any other Thing is. Although I have set down 25 Acres to be sown with *Flax* for a Trial, which you may see to be managed with

160 *l.* Stock; yet I suppose that there is no Man so simple, but when he findeth the great Benefit of 25 Acres, will the next Year sow 50 Acres, which a Man may easily manure by one of those Husbandries which I have formerly expressed; out of which I make good my Assertion thus: Fifty Acres, by the former Account in *Flax* and Turnips, cometh to above 2250 *l.* a Year, besides all other Commodities that may be raised out of that by Land, by Beasts, Sheep, and other Things. Fifty Acres yearly laid down with Clover-Grass (though upon an Experiment of it in *England*, I had Word sent me, an Acre was worth 3 *l.* yet I will value it at 2 *l.*) improves yearly 100 *l.* and in 10 Years 500 Acres of heathy Land improveth to 1000 *l.* a Year, and so by that Means alone, the younger Brother hath attained to his eldest Brother's Estate. But then compute what he may have in ten Years out of the 2250 *l.* a Year above-mentioned: He may be able to double his eldest Brother's Estate in 10 Years; nay, may treble it, if he increases his Quantity of Acres of *Flax* to an 100 Acres, and finds ready Money for that Commodity.

I do know their Clover-Grass in *Flanders* continues but 3 Years perfect after it is sowed; but the Reason of that is, because they always cut it green 3 Times a Year, (except some that they leave for Seed) and that kills it, as it will do Fern: But let it grow to Hay, and be so ripe before you cut it, that some of the Seed may, in  
the



the Making, shatter upon the Ground, and it will always continue after it is once planted.

Here are greater Carps in *Ghent* than any we have in *England*, and because I have observed several Ways in *England*; whereby the muddy and lean Carps may be made in Time both sweet and fat, I will exprefs them as followeth.

First, for breeding of *Fish*: If you have but any Clay-Pit, that is, for Example, but twenty or thirty Rod square, throw some Boughs into it, or Log, whereby the Fish may hang her Spawn, and put into it either one Spawner and two Milters, or two Spawners and three or four Milters; and they will breed you Carps enough to store twenty, nay, may be, forty Acres of Pond. For I had once out of a Pond that was not above 40 Rod square, of 2 Spawners and 3 Milters, fourteen thousand and odd hundred Carps, that were bred there in one Year. To make the Fish sweet and fat, the Way is to have two or three little Stews, one of them always dry and grassed, that you can fill it with Water when you please, to put in your muddy and lean Fish, and in a Month they will grow sweet and fat. Another Way is, to take a Bushel or two of Grains, and mingle with them as much Chalk and Marle, or Clay dried, and beat it to Dust, and make it all together into a Paste, and ram it hard into a Barrel, where you must make several Holes for the Carps to put in their Heads, and then throw

it into the Pond, and it will fat your Carps exceedingly.

Another Way is to lay a Pond dry, and sow it with Barley, and when it is grown as long as your Hand, then fill it with Water, and put your Fish into it, and they will grow sweet and fat exceedingly: But for such Carps as you mean to feed, let them be Milters or barren Carps, for you shall seldom see a Spawner fat.

Amongst the several Observations before made, the main Profit to make a Man rich indeed, is the *Flax*; Concerning which I have had a Question asked me, Why they do not sow all their Land with *Flax*, if it bring such huge Profit beyond other Commodities? and why these Men that sow it are not infinitely rich? For which I confess (tho' I am well satisfied in the Truth of the Thing by those Experiments I have made) I could never learn of other Answers, than these: First, that all the Land is not natural for *Flax*; and namely, not all Land, but either a Sand or a light Loam; because the Ground where it is sowed must be made as fine as any Garden Mould; for your *Flax* will not grow kindly where there is any Clot, or Stones. Secondly, for that the Seed is some Years very chargeable, and has been sold in *Ghent* at 15 Shillings a Bushel, because your outlandish Seed came not over in Time, which most Husbandmen buy and sow their Land, having converted their own Seed

Seed



Seed before to Oil; and so a Gamet, upon which they sow their 6 Bushels, will cost in Seed 4*l.* 10*s.* And if there come not Rain in ten or twelve Days after the Seed is sown, their Crop (they make account) is as good as lost, unless they sow it again. And that is one Reason makes poor People, they dare not venture to sow much; and they are not ordinarily so much subject to Rain there as we are in *England*, ours being an Island, and their's a Continent. Another Reason is, because few Men that are Owners of Land there live upon it themselves, for fear of its being perpetually spoiled by Soldiers; and therefore they all live in walled Towns, and let out their Land to Boors, whom they tie by Covenants not to sow any great Quantity of Land with *Flax*, because they have an Opinion that it barrens the Land, and will not let them sow the same Land but once in seven Years; but I think it is rather for fear they should grow too rich. Another Reason, because almost all their Land that can be ploughed is kept in perpetual Tillage with one Seed or other; and they have no Help but Dung, of which they have but small Quantity, in respect they have no waste Land, and therefore can keep very few Cattle or Sheep to raise it; but most of these Inconveniencies will be remedied in *England*.

Note, As I have already observed, when you have ploughed up all your heathy Land, you may break up that Land for *Flax* and Turnips,

which you first laid down with Clover-Grass. Because you shall not think much to do if you may observe, by this Discourse, that five Acres sown with Flax and Turnips, if it prove right, is more worth yearly than a thousand Acres of Clover-Grass, which will also require ten Times the Stock more.

*The Way concerning the Husbandry in general  
of FLAX.*

**Y**OU must first chuse sandy or loamy Ground, and manure it well, and lay it as fine as possibly you can; and then be sure to chuse good Seed, and sow at least four Bushels of it upon an *English* Acre, and chuse such a Time to sow it in, as probably, by Signs of the Wind or Weather, you may, by God's Blessing, have some Rain within ten Days after it is sowed; for your Season will last in *England* to sow it, from *Mid-March* until a Week in *June*; albeit *April* be the best Season of the Year, in regard the nippingest Frosts are past by that Time, and for that in that Month, you are likeliest to have Rain. When the Flax is grown a Handful high, you must weed it; and although you tread or lie upon it at that Height, it will rise again: When the Buttons of the Flax begin to look brown, you must pull the Flax, and then comb off the Buttons, and lay them abroad, where they may dry; and as the Outside withers,



thers, the Flax-Seed will ripen within; but that Seed will be only fit to make Oil, but not to sow: For if you will save any Seed to sow, you must let your Flax stand until your Seed be thorough ripe, and then you lose very much in the Weight of the Flax, which is otherwise more profitable to you by much than your Seed. After you have combed off the Buttons, you must presently put your Flax in Water, but it must be standing Water, and such as will not discolour it; where it must be about seven or eight Days ordinarily: But that Rule is ordered according as the Weather proves hotter or colder. Then it must be seven or eight Days laid out a drying, being now and then turned; and when it is dry enough, it must be put into a Barn, where it must lie in Heaps seven or eight Days more a sweating, before you must do any Thing else to it. But to order the Business well, you must be sure to have one of Experience until you can come to understand every Particular yourself. When it hath sweat enough in the Barn, then it must be beaten, or breaked, or hackled, and then it is fit for the Market.

After you have pulled your Flax, you must then plough your Ground for Turnips. Two Pound and a Half of Turnip Seed will sow an Acre. After your Turnips be off, in *April* following you may sow the same Ground with Barley or Oats, and with it sow your Clover-Grass, whereof nine Pound will sow an Acre; and by

that Time you have mowed your Oats, your Ground will be stocked with Clover-Grafs.

*A Way to make infinite Profit by SKAROTS.*

**Y**OU must let as many Skarots lie in the Ground all Winter as you think necessary for Plants: They will be sprouted up in *March*, and then you must divide the Top of the Root into single Plants. Plant them in rainy Weather, they will be ready to eat by *Christmas*. You must dung the Ground for them every Year where you sow them: Cow Dung is the best; but never sow the same Land with them two Years together. Those which come of Seed the first Year, are never so good as those which are transplanted; and the Plants seldom fail if they be planted in moist Weather. If they be trod about the Roots they will thrive the better; and they do not prove best in a light Land. You may keep them as long as you will after you have taken them up, laying a Lane of Earth, and a Lane of Skarots still one upon another; or you may let them lie in the Ground till *Easter*. They never cut the Stalks, but let them wither of themselves.

An *English* Rod of sixteen Foot and a half Square, is thirty-three half Foot square; and your Skarots being planted half a Foot one from another, a Rod of Ground will contain one thousand and eighty nine Plants; every Plant  
that



that grows may very well produce three and four Roots; but because some Plants may fail, compute not the odd eighty nine, but suppose you may have three thousand Roots out of a thousand Plants; and twelve Roots being sold for a Stiver, the three thousand upon a Rod come to 25*s.* *English*, but if sold for an *English* Penny, come but to 20*s.* and 10*d.* But according to that Account, there being eightscore Rod to an Acre, an Acre is worth 166*l.* 13*s.* 11*d.*

If you think your Skarots will be eaten with Worms, than dress your Land with Lime, *viz.* Lay four Load upon an Acre, *viz.* a Bushel upon a Rod, there being eightscore Bushels in four Load, and use it in this Manner; Take your Lime unslaked from the Kiln; and after you have digged up your Land, cover your Lime a good Thickness with the Earth, so as there may be three or four Load of Earth to cover a Bushel of Lime, and there let it flake in the Earth; and then before you set your Skarots, mingle the Lime and Earth together, and spread it upon the Land, and that will keep away the Worms.

### *Of Roman BEANS.*

**A**N *English* Merchant carried from *Flanders* into *England* some *Roman* Beans, that yielded him an Increase of two hundred

and fifty Beans for one, and by only setting an Handful or two, he had the next Year as many as he made forty Pounds of, by selling them to a Corn-Chandler near *Strand-Bridge*, at sixteen Shillings the Bushel. These Beans are to be set about *Mid-May*, at half a Foot distance from one another, and afterwards to be brought to Poles like Hops.

To inform myself of the Commodity and Profit of these Beans, I bought a Pint, which cost me three Stivers, and told all the Beans of that Pint, which were eight hundred and forty-four: I doubled them to a Quart, which was sixteen hundred and eighty eight; then to a Pottle, which was three thousand three hundred and seventy six; then to a Gallon, which was six thousand seven hundred and fifty two; then to eight Gallons, which is a Bushel by our *English* Statute Measure, which contained fifty four thousand and sixteen Beans: Then I cast up how many Beans might be set upon an *English* Rod, which was thirty-three half Foot square, at half a Foot asunder, and I found it would take up one thousand and eighty-nine Beans; and that by the same Account, there might be set upon an Acre, which was eightscore Rod, 174,240, which was three Bushel, and 12,092 Beans over, which was near a Peck more. I then computed what Beans were usually sold at in *Ghent*, which was three Stivers a Pint; which amounted to nineteen Shillings *English* the Bushel: I computed



puted then what Charge belonged to a Rod, according to the *English* Account, as followeth:

First, I valued an Acre of Land at 13 s. 4 d.

So a Rod is but 1 d.

Half a Quarter of a Load of Dung to dress a Rod, according to twenty Load to an Acre, 1 d.  $\frac{1}{2}$ .

Trenching a Rod worth 3 d.

A Pint and Quarter and thirty-four Beans, being in all one thousand and eighty-nine Beans, 4 d.  $\frac{1}{2}$ .

The Poles, an hundred and twenty-one, at 3 s. a hundred, allowing the Branches of nine Beans to a Pole, 16 s.

The setting, poling, pulling, &c. 8 d.

So the whole Charge of a Rod comes to 7 s. 6 d.

Now, if a Pint, and a Quarter, and thirty-four Beans do produce two hundred and fifty Times as many, then a Rod reckoned at 250 l. 4 d.  $\frac{1}{2}$  cometh to 4 l. 13 s. 9 d.

Then deducting the Charge of 7 s. 6 d. there is clear Gain in a Rod 4 l. 6 s. 3 d.

According to which Account, compute the Gain of one hundred and sixty Rod, which is an Acre, 750 l.

Out of which is to be deducted eightscore Times 7 s. 6 d. for Charges, 60 l.

So there remaineth clear Gain for an Acre 690 l.

But

But your Poles, which is the greatest, will last five or six Years.

The only Way to vent these Beans, is to sell them for the Use of the Navy, or to Merchant Ships.

*To raise Sallads, Pulse, and all Sort of Grain in a short Time.*

**I**T is to be observed, that that which renders a Piece of Ground more fertile and productive than another, is the Quantity of the Nitre in it; So that if Seeds can receive such a Quantity of Nitre as is sufficient, before they are thrown in the Earth, they will shoot with Precipitation.

Tho' Wheat Water is mentioned in the Composition underneath, it is not absolutely necessary. I have found, that common Water (Rain Water, if it can be had) in which good rotten Horse Dung, or rather Sheeps Dung, has been steeped, will do as well; in which some refined Salt Petre must be dissolved. This is all the Mystery. In this Liquor Seeds are to be steeped more or less, according to their Qualities.

As to the exact Quantity of Salt Petre, it is difficult to fix it. Experience in this Case is the best Guide. Too much would burn the Seeds, and too little would not answer the End. But according to the Proportions that I have tried, it is as follows.

Take



Take about a Pail and a Half of Water, steep in it a Bushel of new Wheat, boil it till the Wheat is ready to burst : When it is cold, strain this Water, and the Wheat, to get out all the Substance. Add to this about two Pails of Dung Water aforementioned, and a Quarter of a Pound of refined Salt Petre, and two Pound and Half of Sheeps Dung. Boil this all together, stirring it well till the Salt Petre and Sheeps Dung be dissolved. When it is cold, put in your Wheat, Pease, or Beans, to steep : The Wheat about twelve Hours, unless you observe that it begins to shoot sooner : Then take it out, and lay it upon Boards in the Shade, and turn it often and gently, till it be almost dry, then sow it ; and one Grain of such Wheat will produce thirty or forty Ears of Corn.

Pease must steep as long as Wheat, Beans something less.

As for other Seeds, the Judgment of the Person that makes the Experiment must be the Rule. For some will grow soft in Water much sooner than others.

This Water is very good for all Sorts of Fruit Trees. The Root must be opened a little, and some of this Water thrown on it, and the Earth round watered with it.

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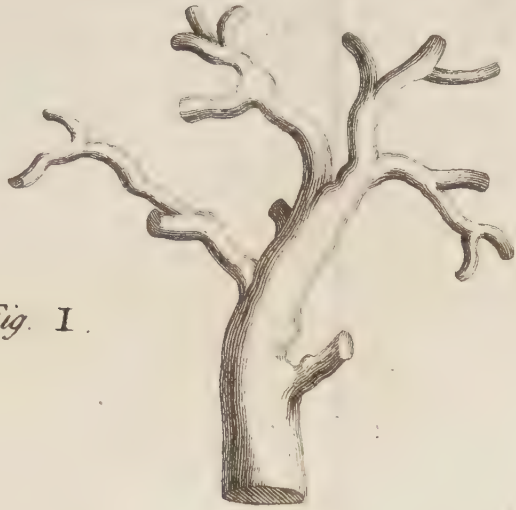
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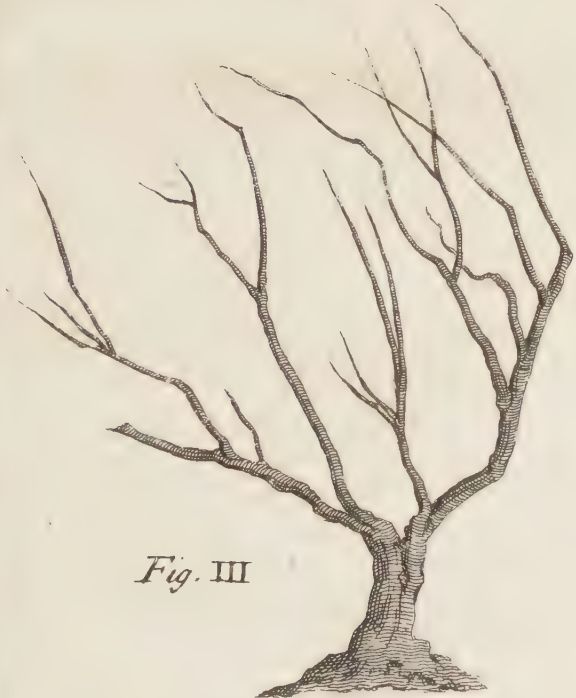
*Fig. I.*



*Fig. II.*



*Fig. III.*



*Fig. IV.*

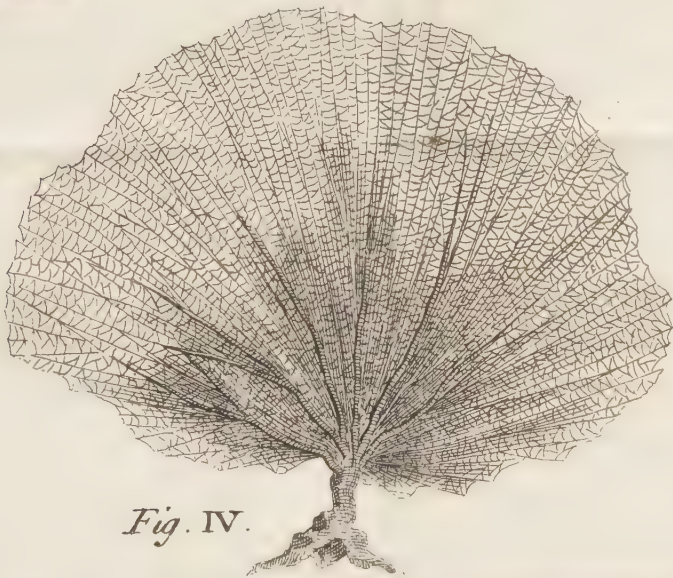






Fig. I

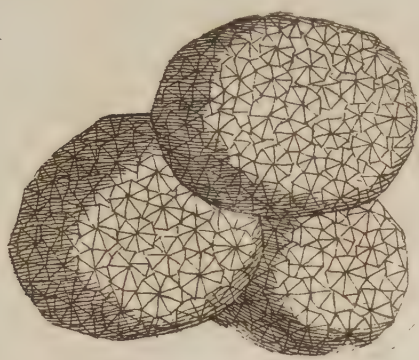


Fig. 2



Fig. IV

Fig. III

Fig. V



Fig. VI

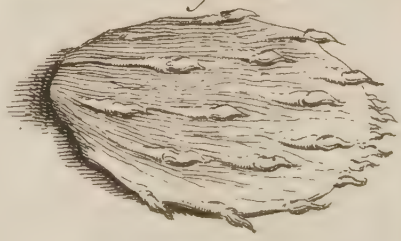








Fig. IV.



Fig. I.



Fig. II.

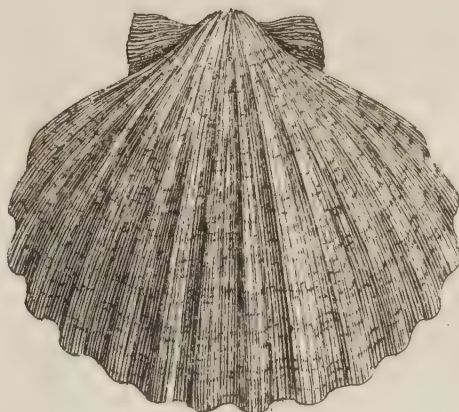


Fig. III.







Fig. IV.

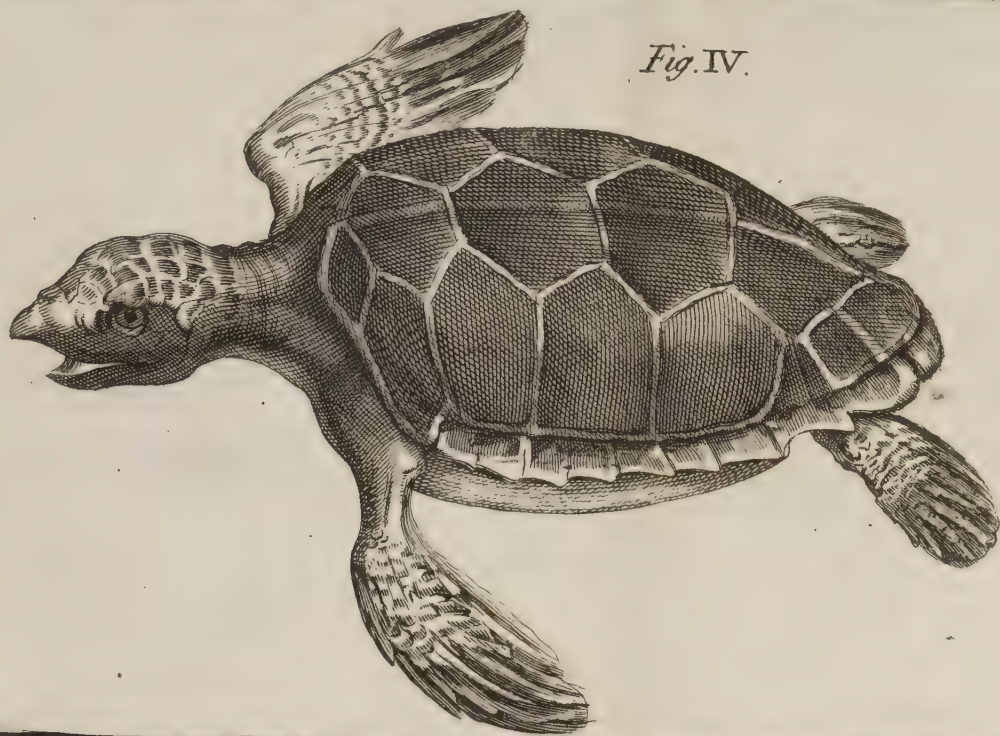


Fig. II.

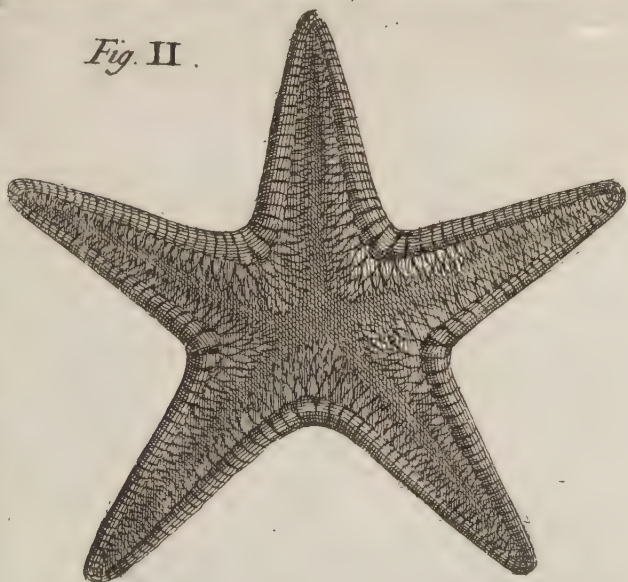


Fig. I.

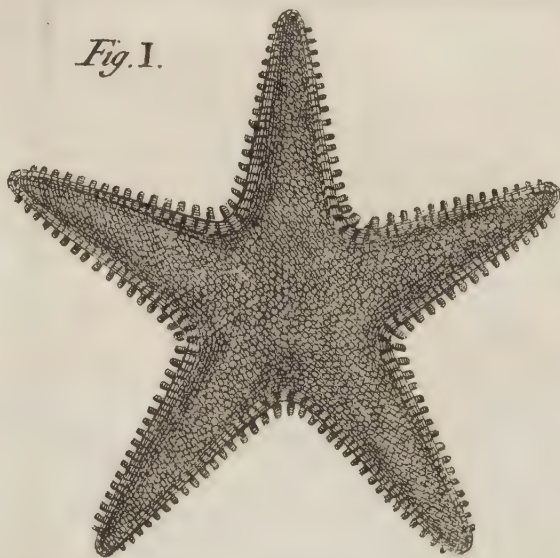


Fig. III.









Fig. I.



Fig. II.

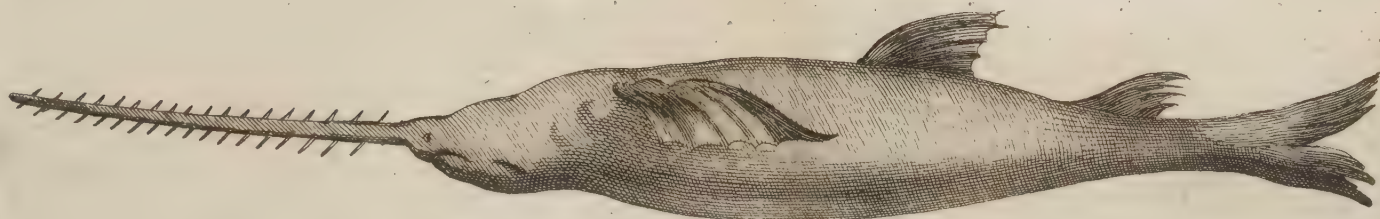


Fig. III.







Fig. I.



Fig. II.

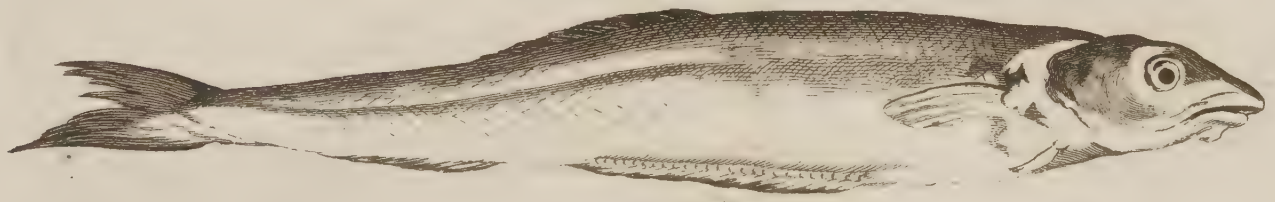


Fig. III.







Fig. III.

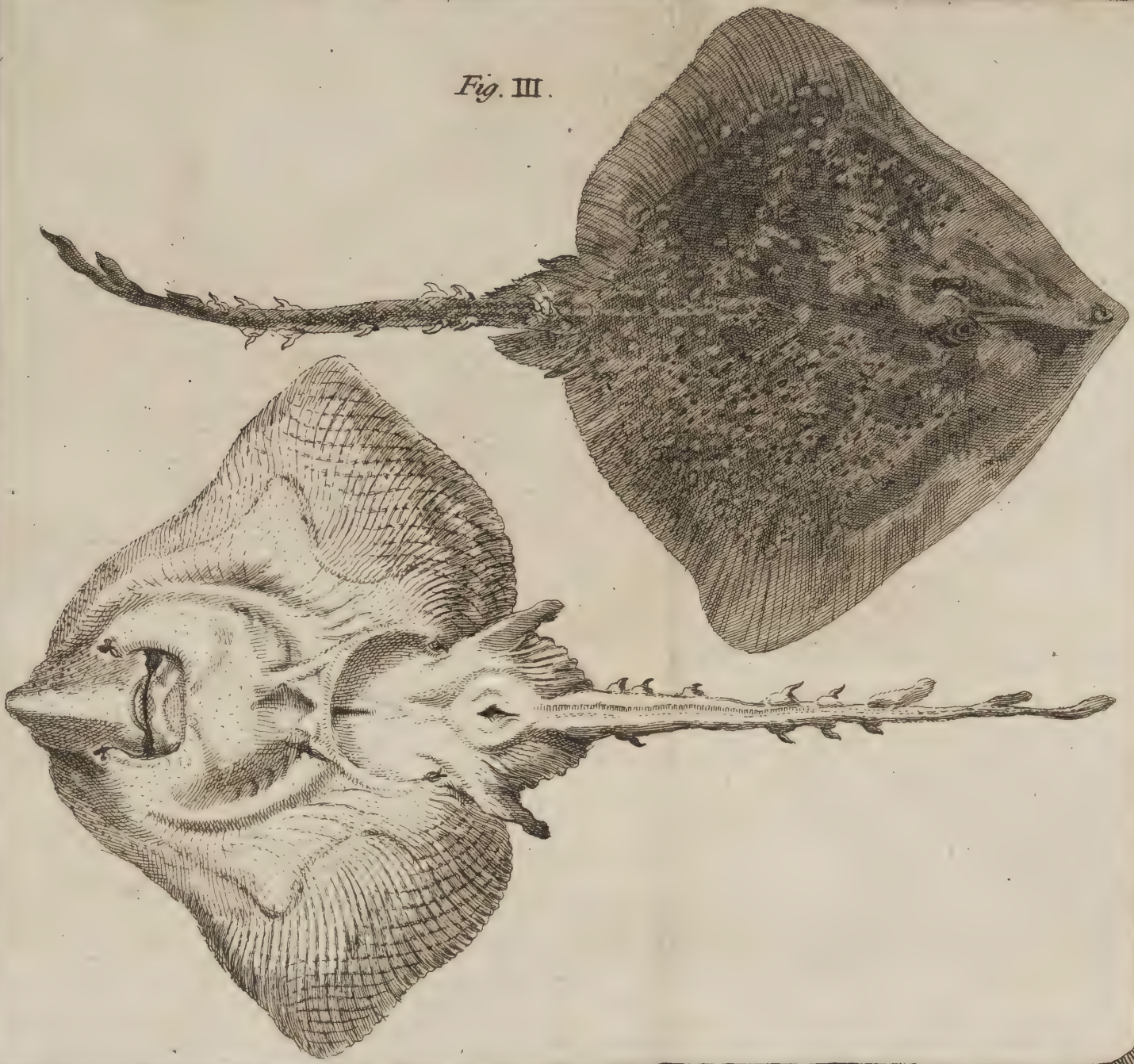


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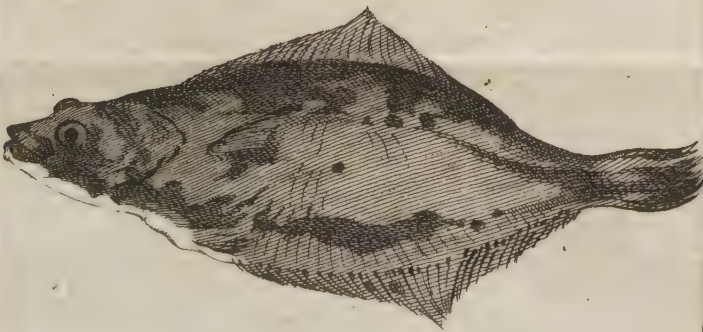


Fig. I.









Fig. I



Fig. II

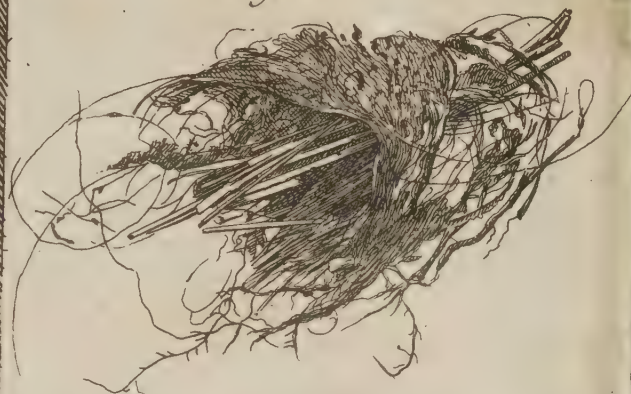


Fig. III





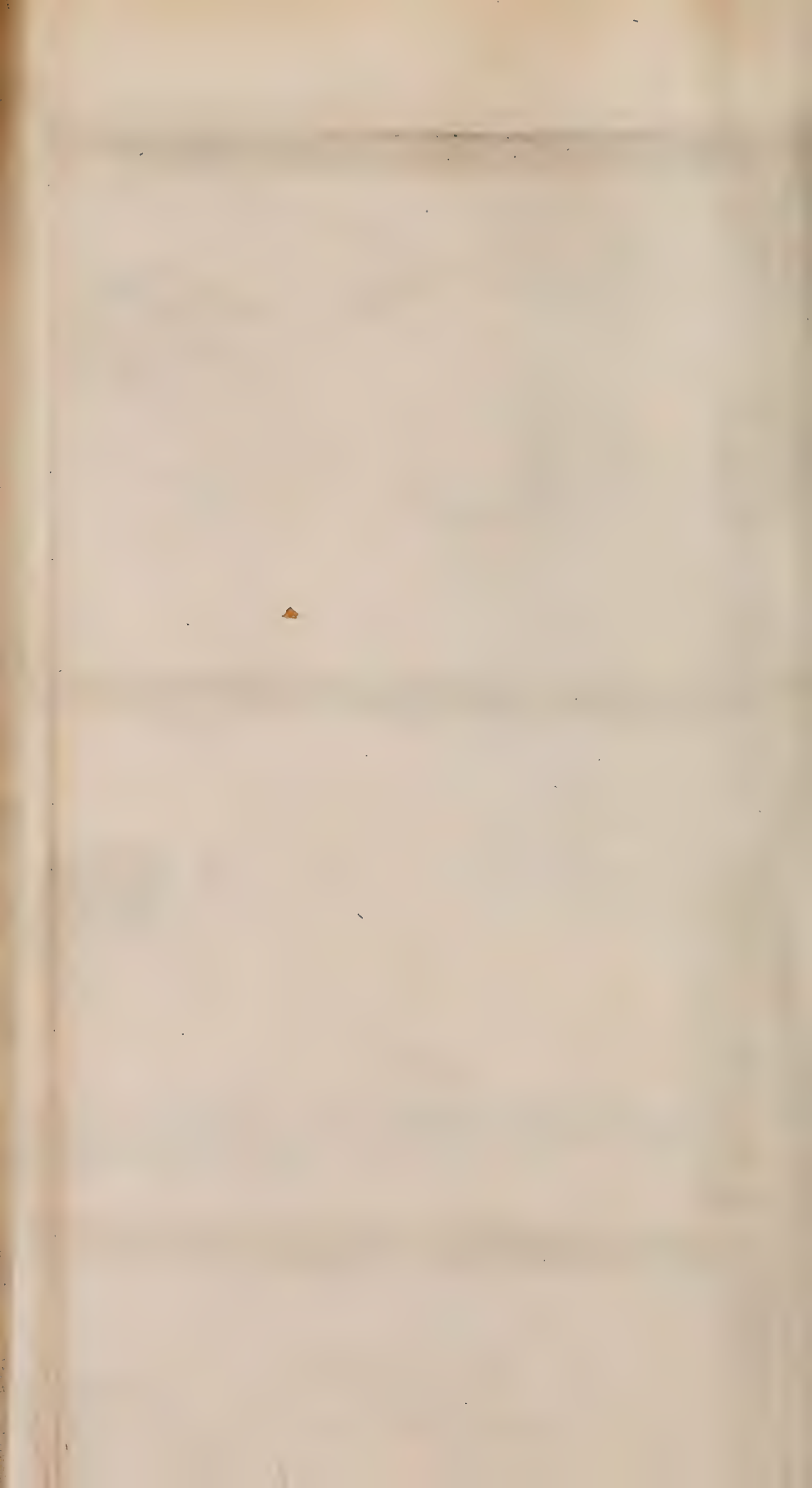




Fig. I



Fig. II



Fig. III







Fig. I



Fig. II



Fig. III







Fig. I.

Fig. III.

Fig. II.

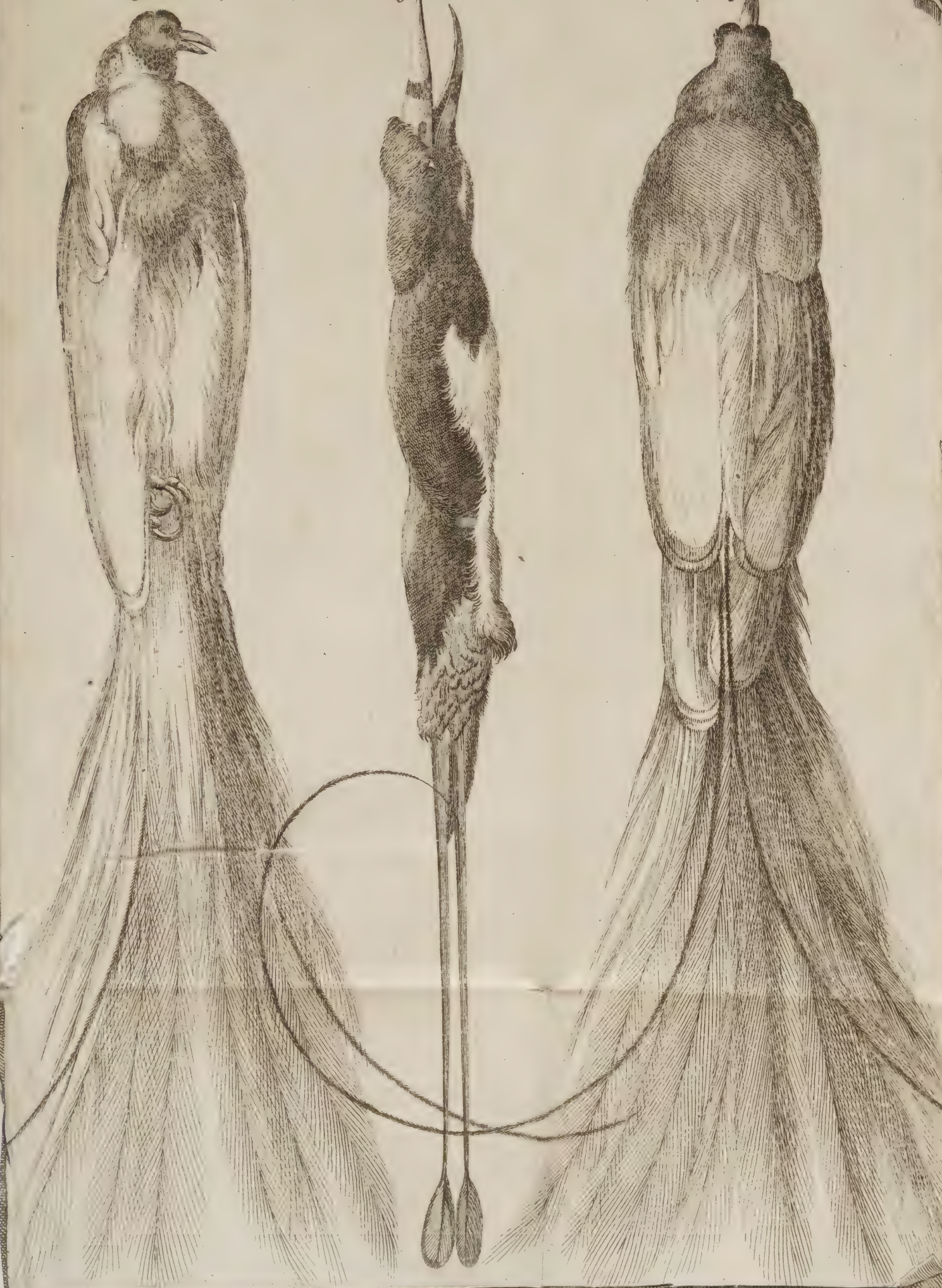






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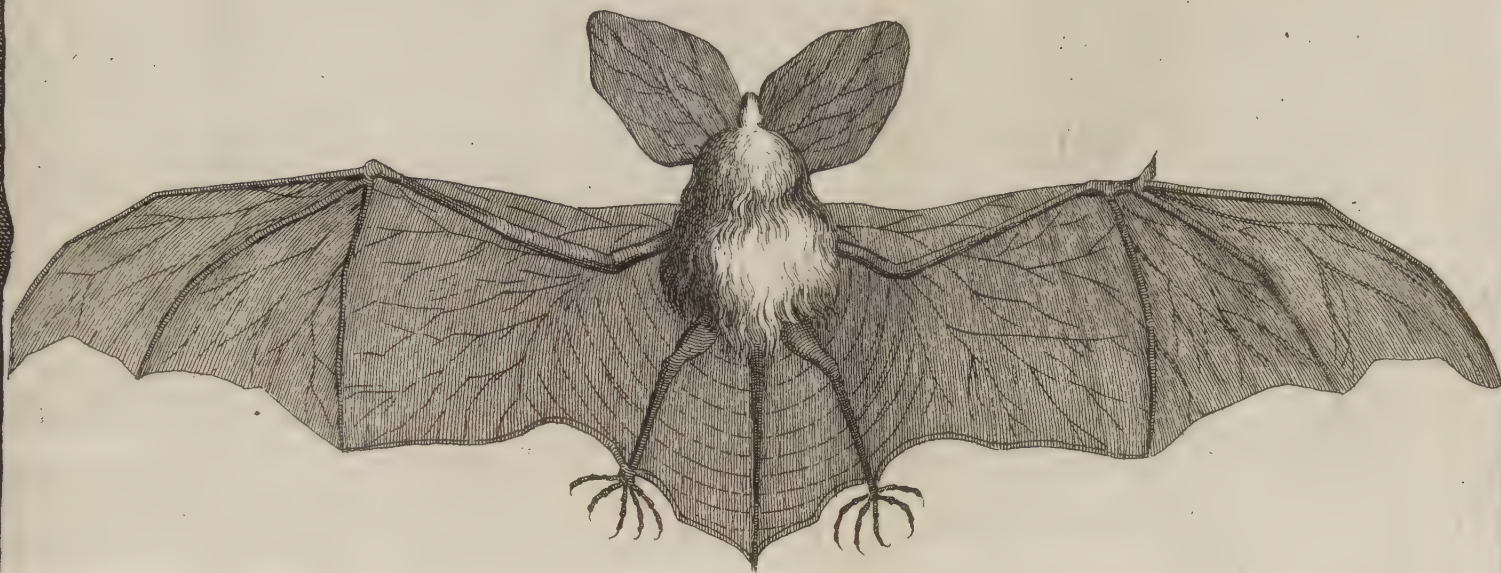
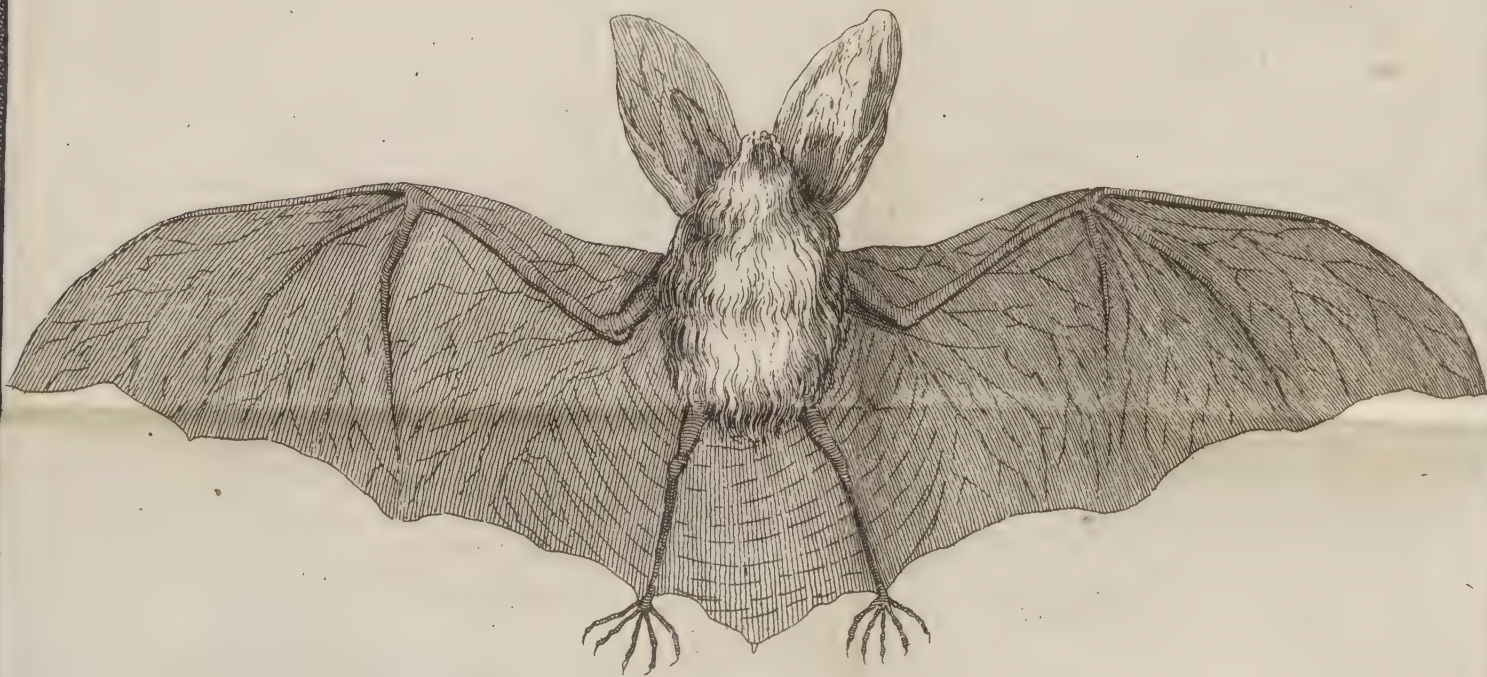


Fig. II



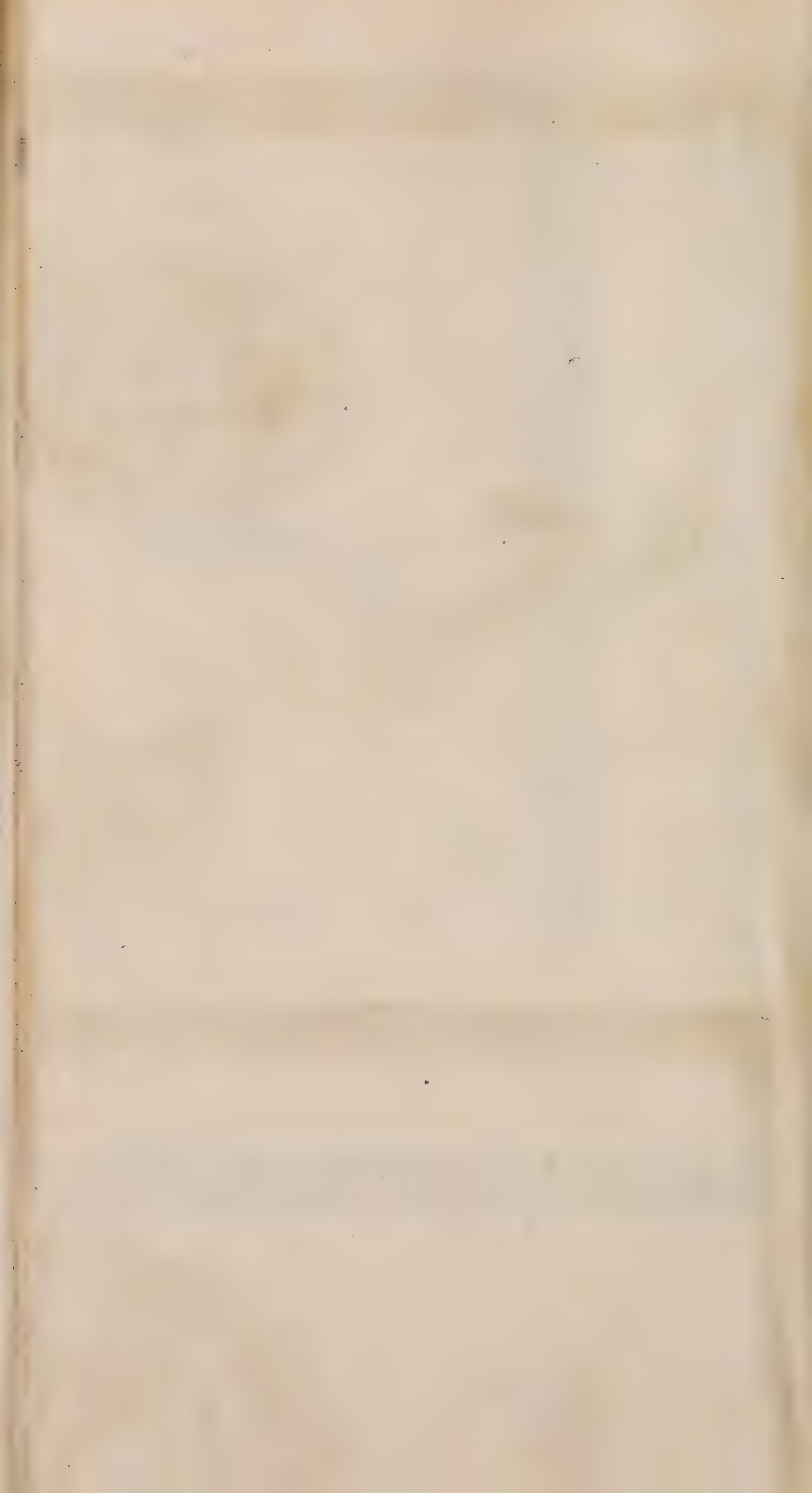




Fig. I.



Fig. II.

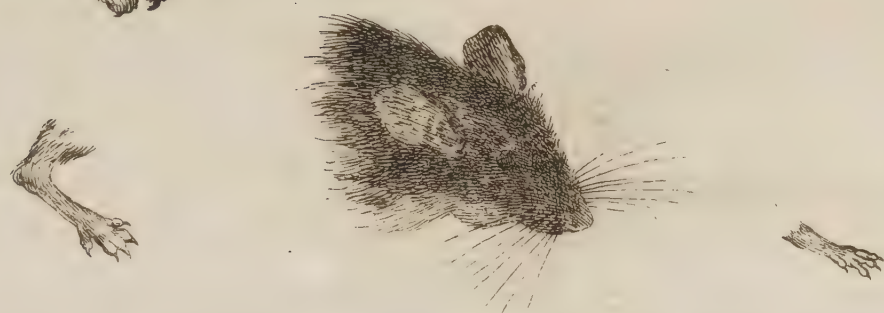


Fig. III.







Fig. I



Fig. II



Fig. III

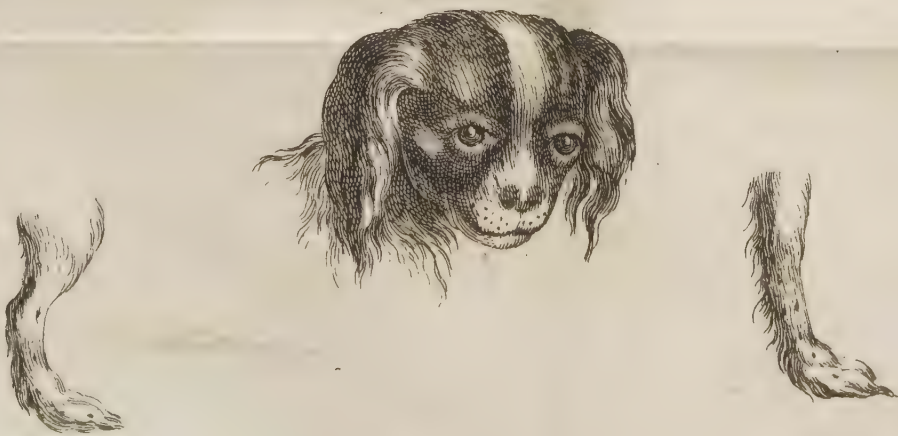












Fig. I.

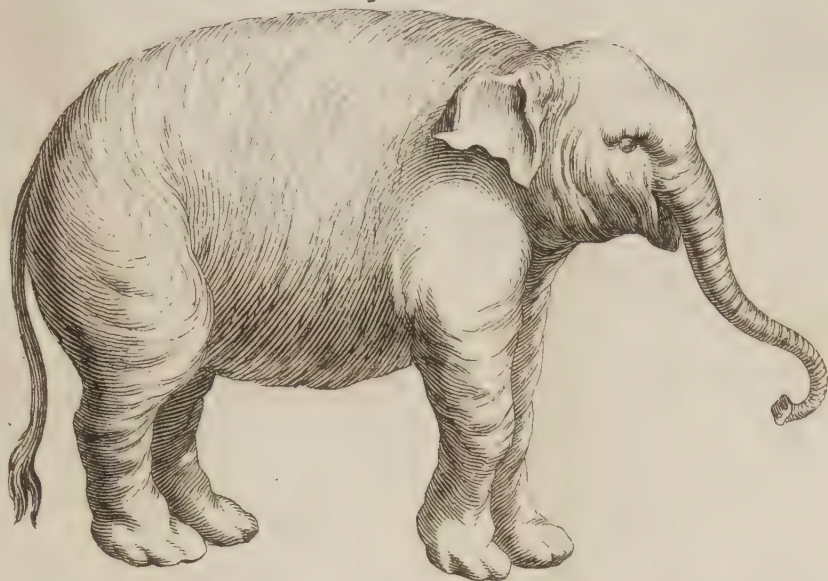


Fig. II.



Fig. III.



Fig. IV.









Fig. III.

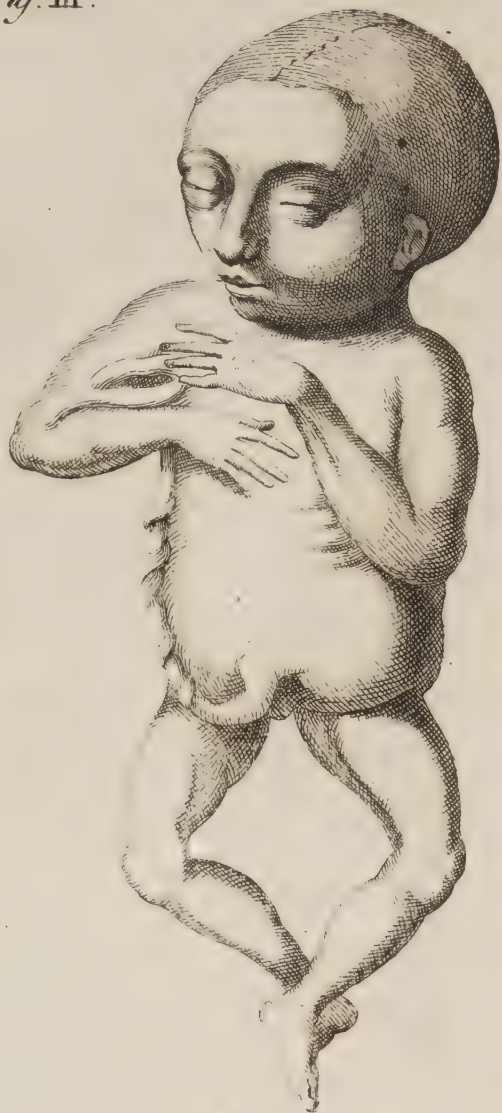


Fig. II.



Fig. I.

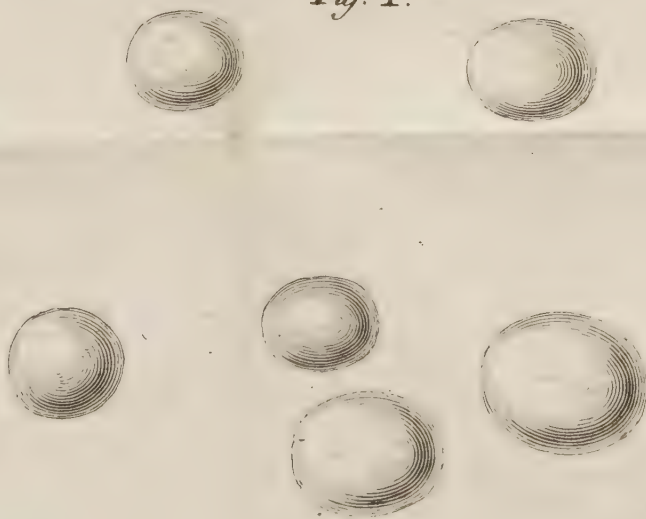


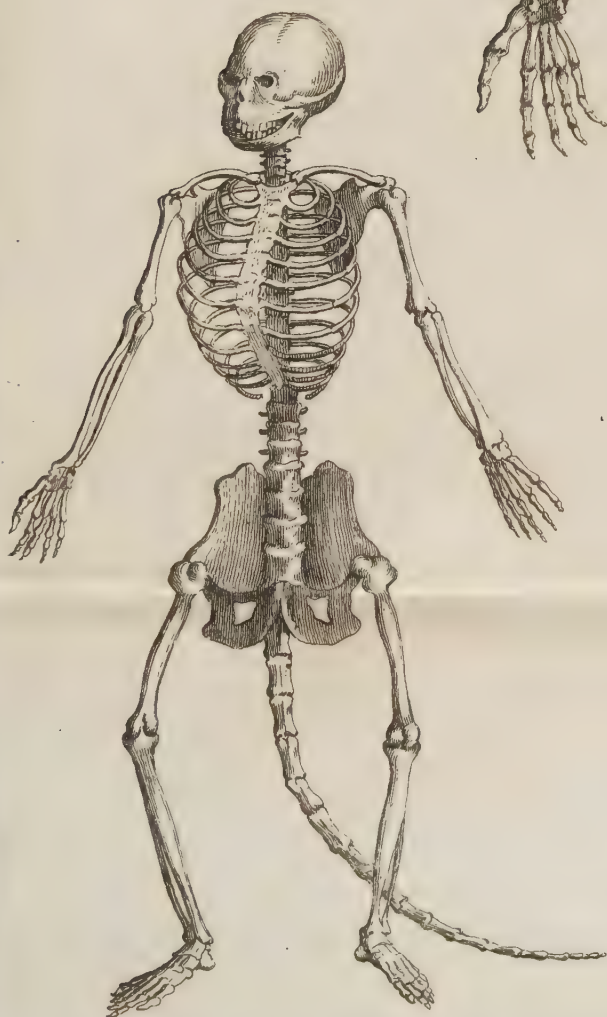


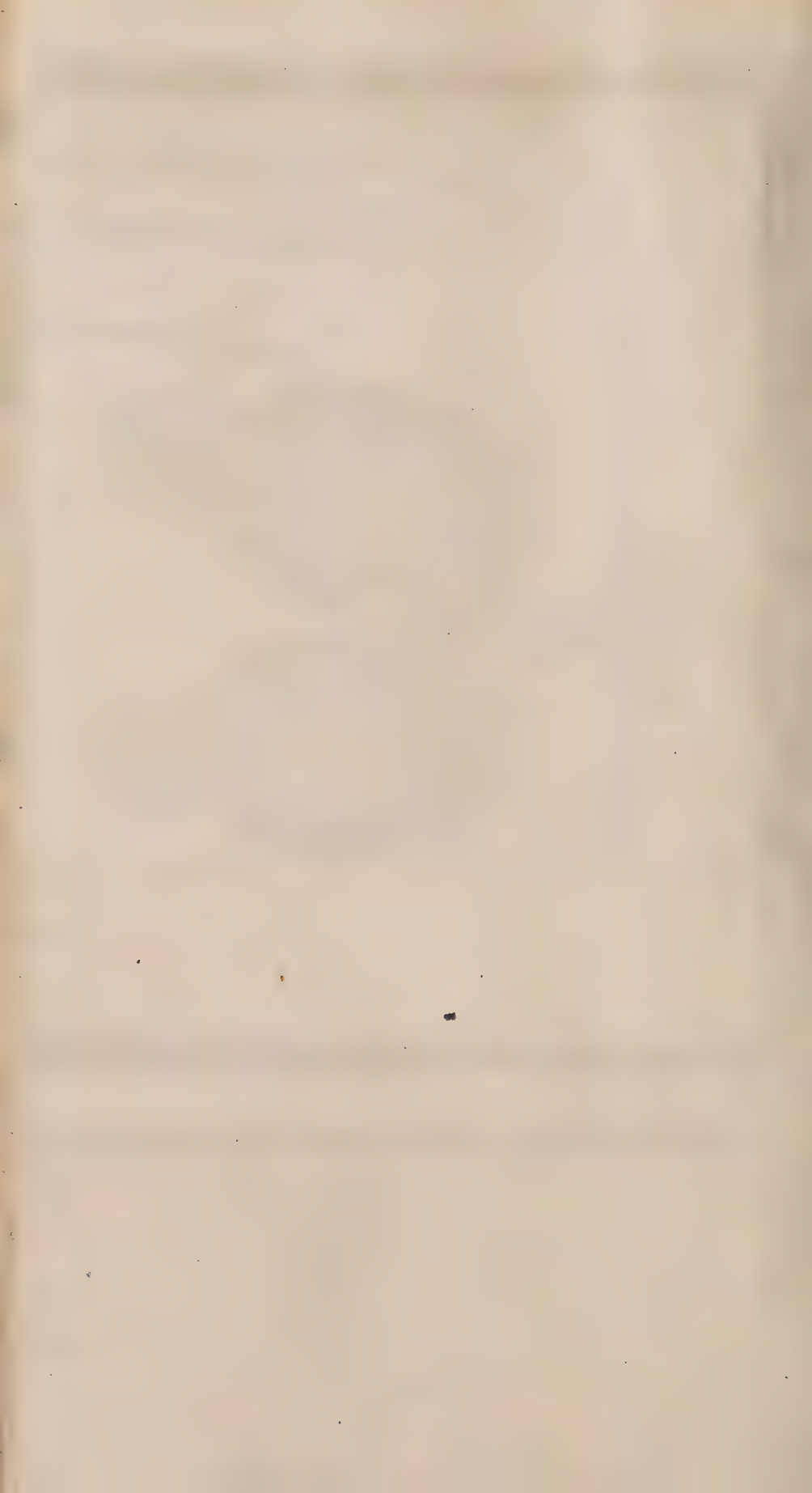


Fig. I.



Fig. II.







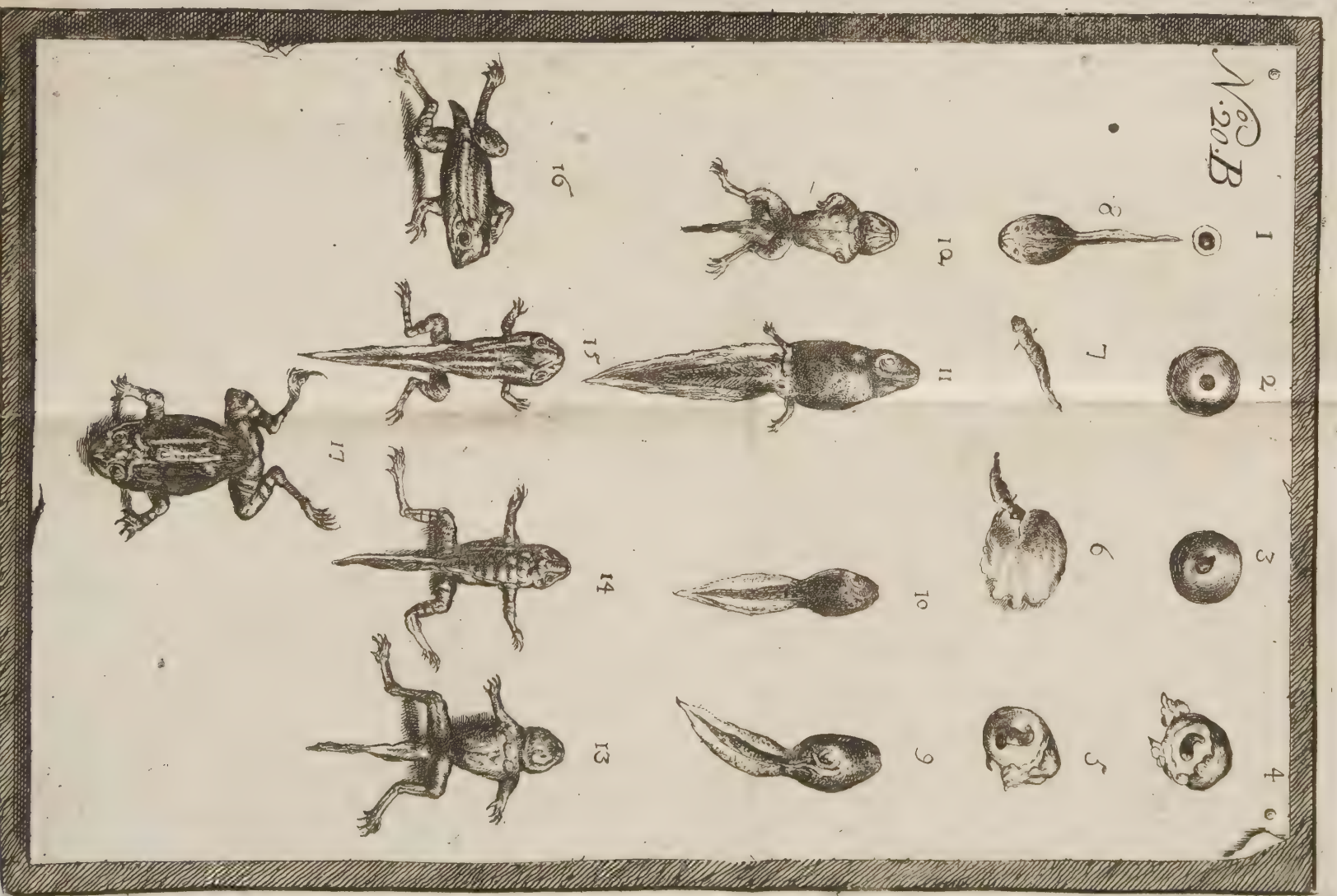
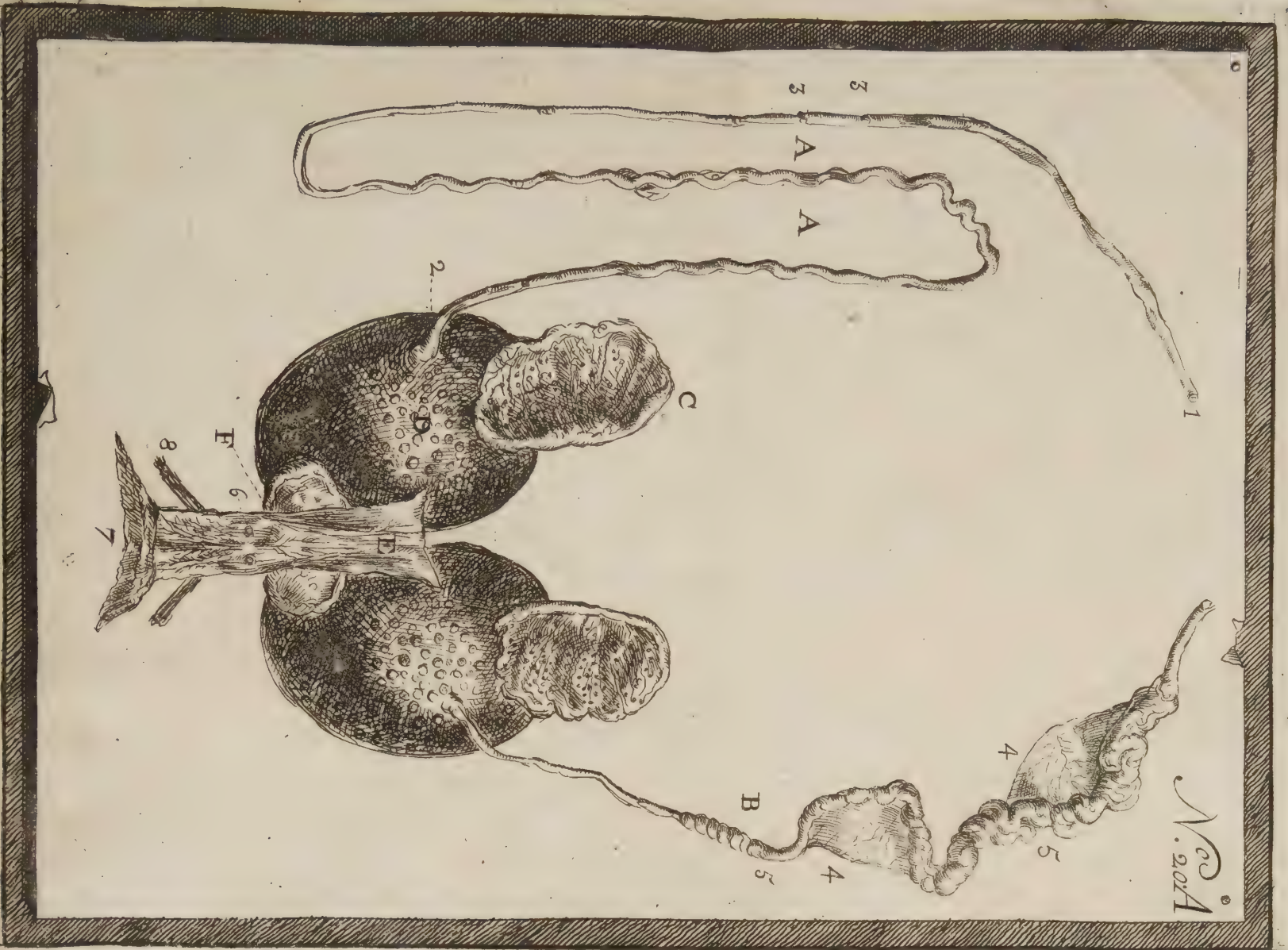






Fig. I.



Fig. II.









Fig. I.









Fig. I



Fig. II.

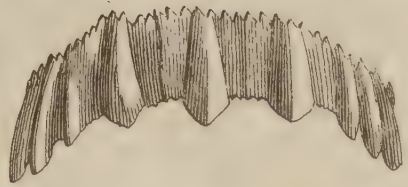


Fig. III



Fig. III

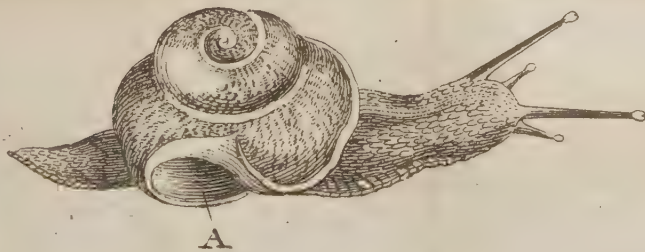












FIG. I.



FIG. II.



FIG. III.



FIG. IV.

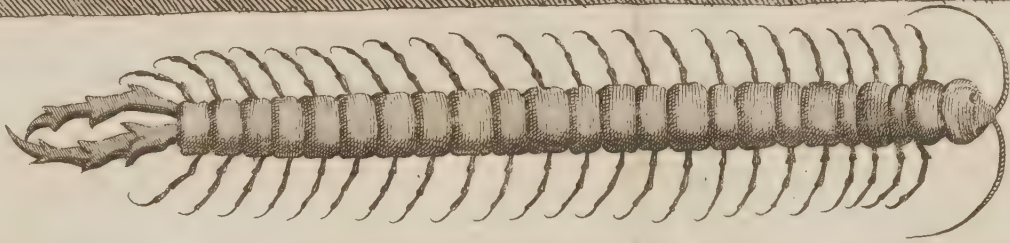


FIG. V.







Fig. I



Fig. II

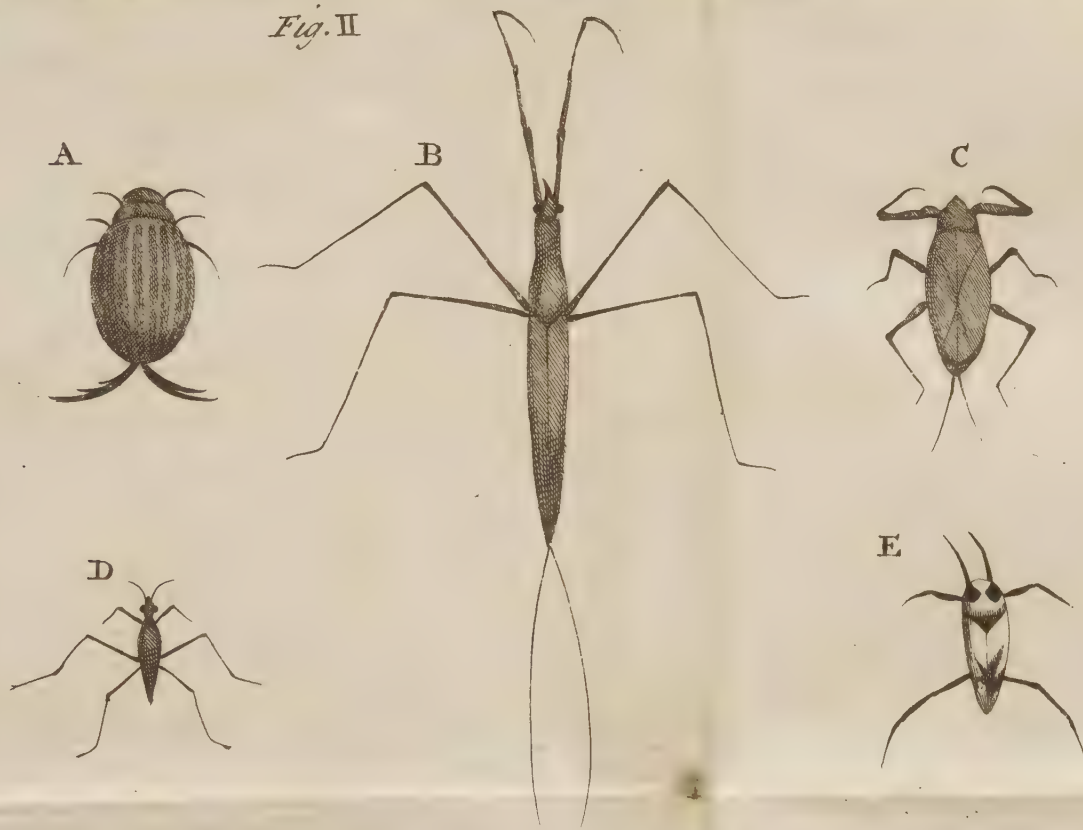


Fig. III

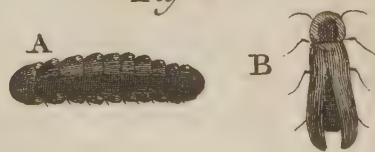


Fig. IV



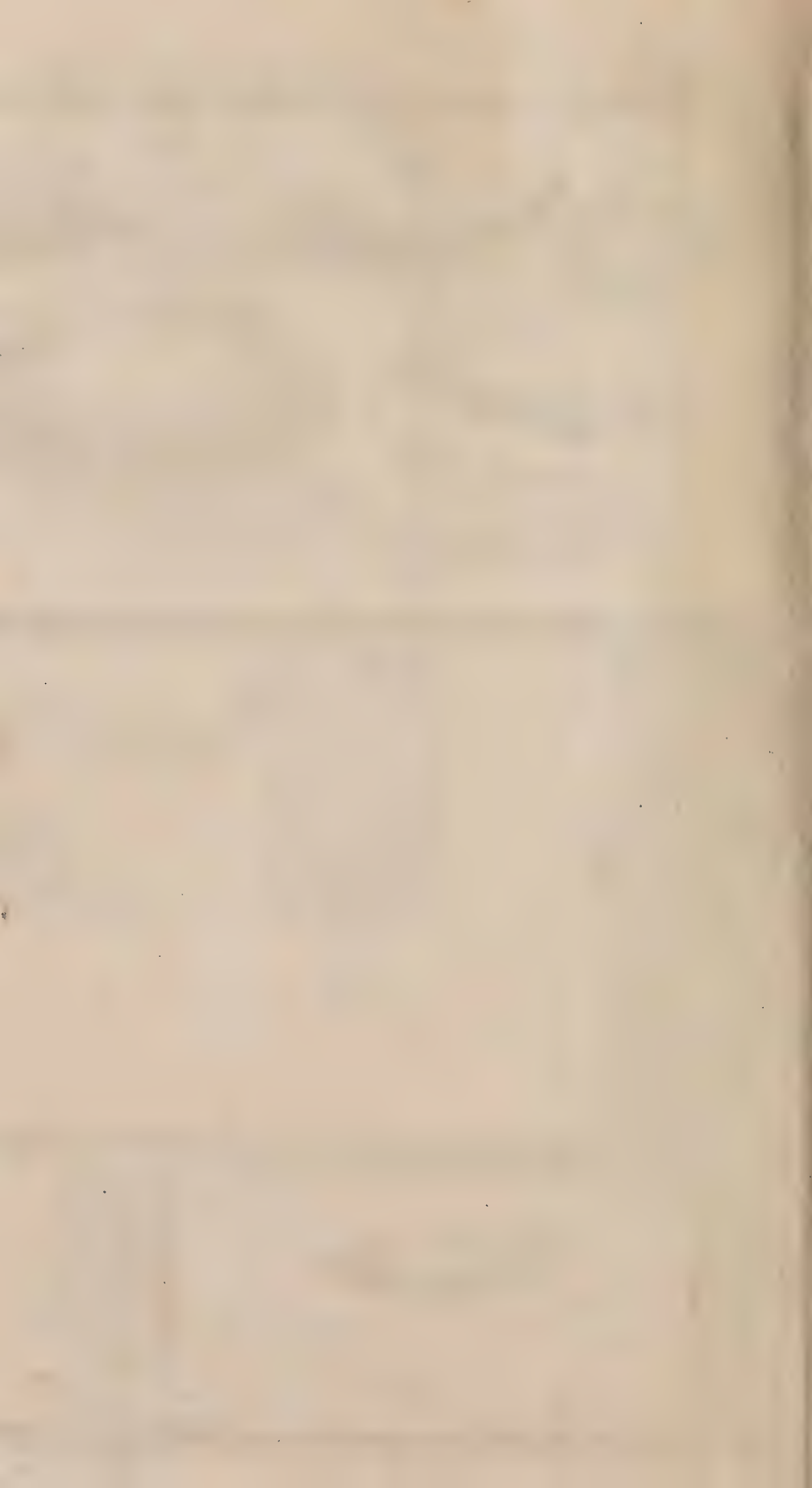




Fig. I

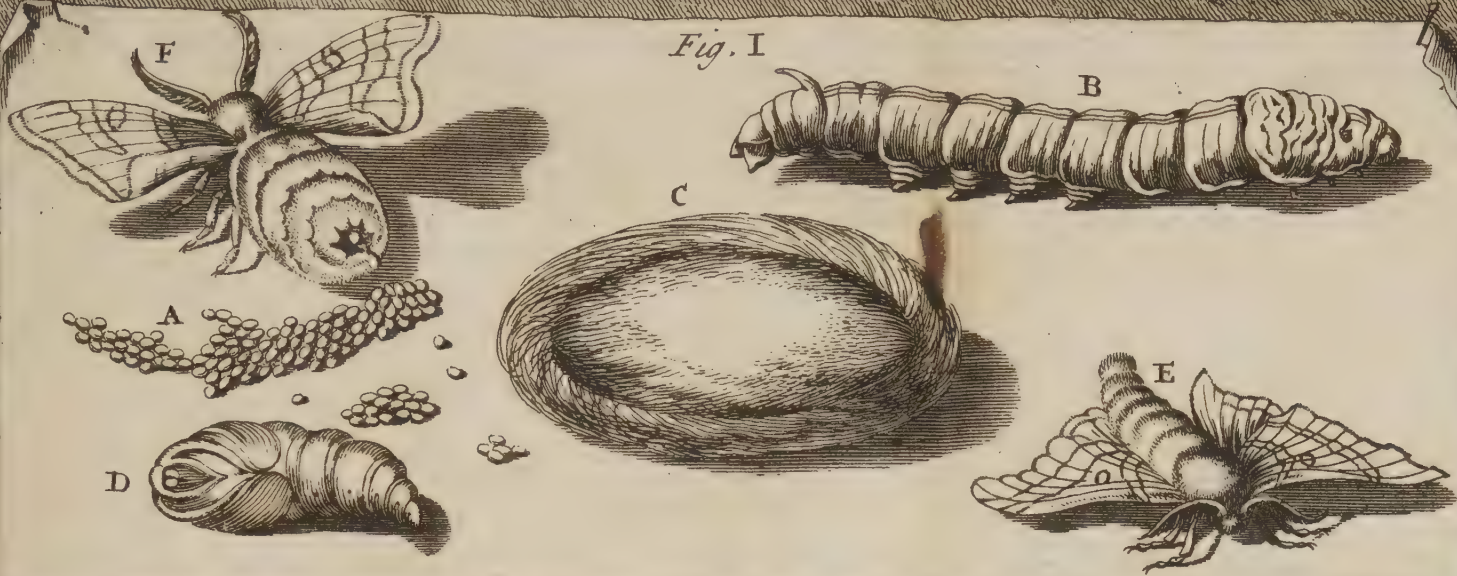


Fig. II.



Fig. III

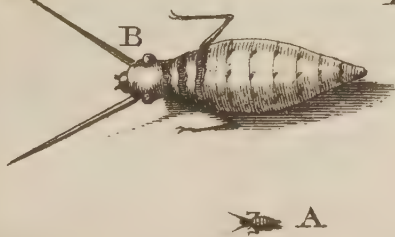


Fig. IV



Fig. V

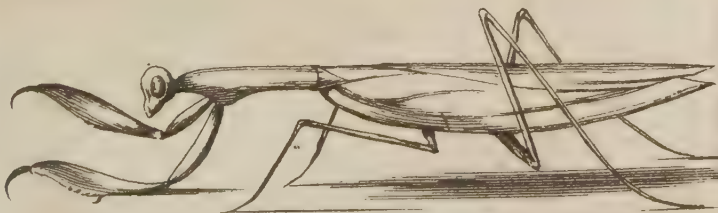
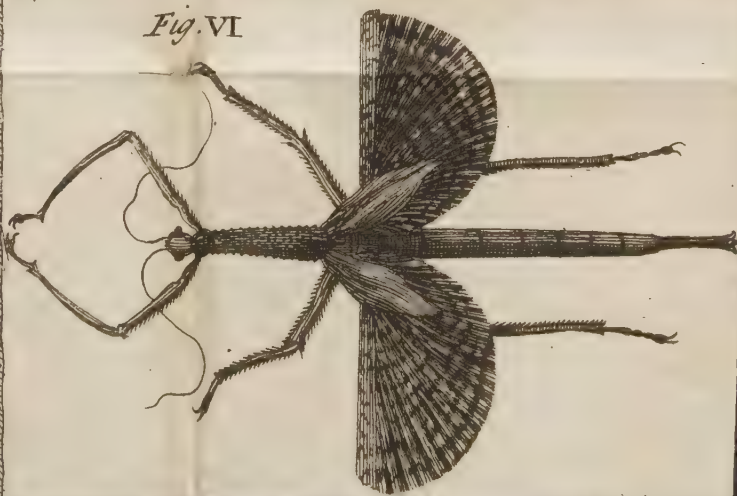


Fig. VI



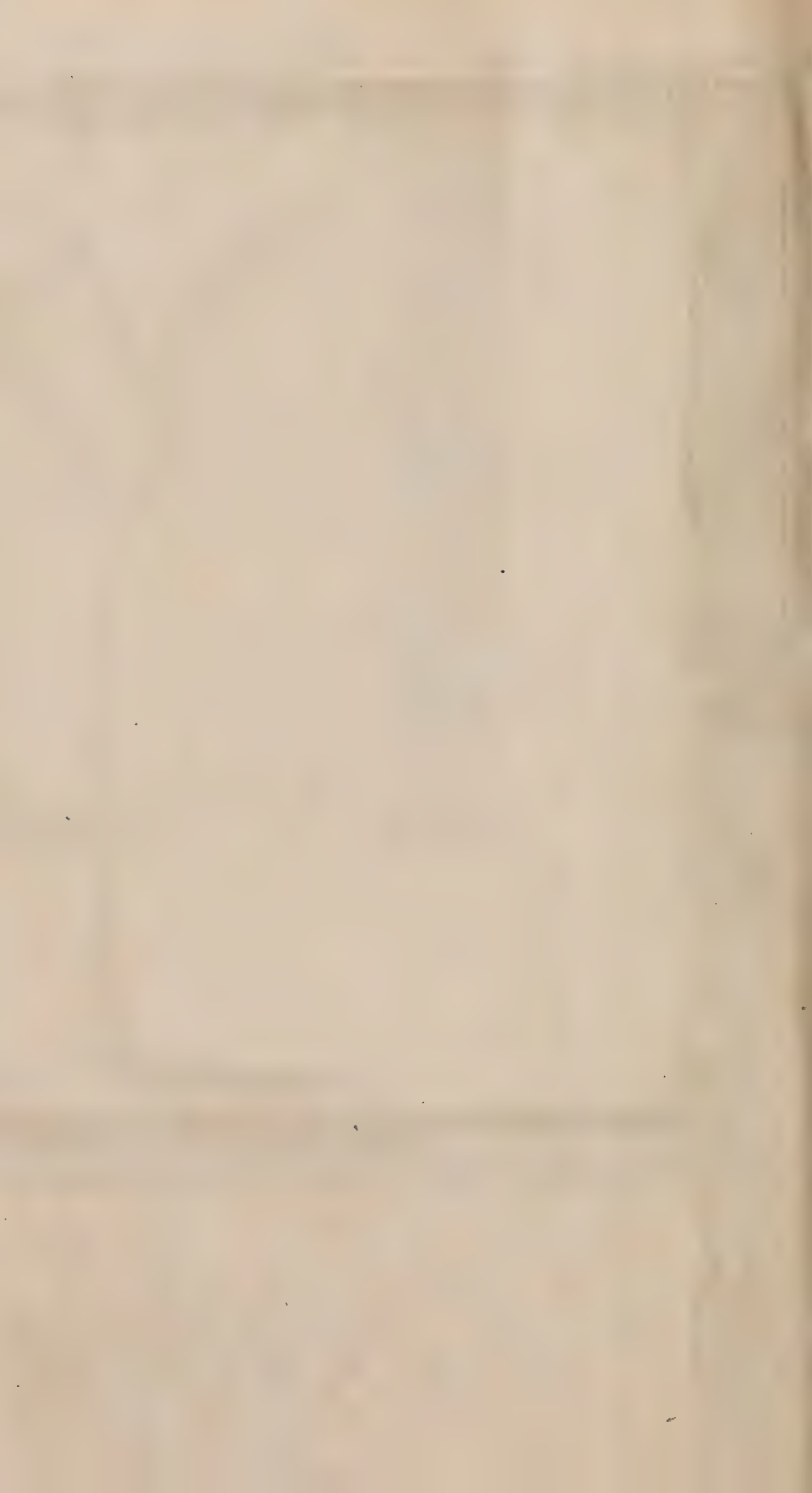




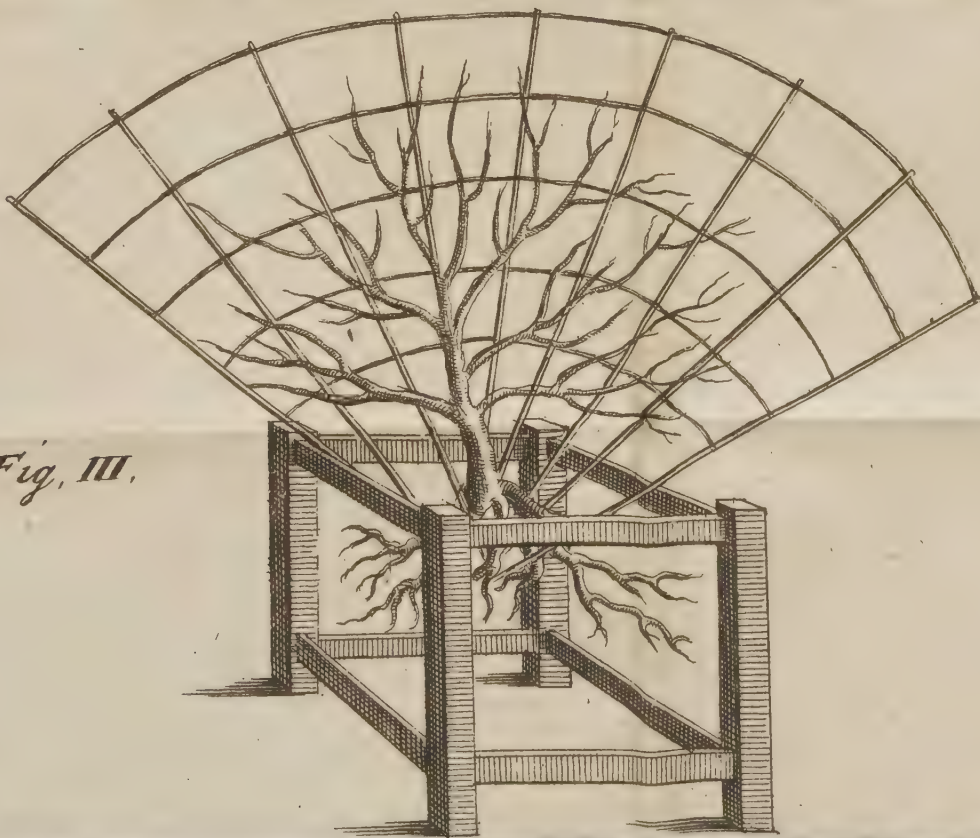
Fig. I.



Fig. II.



Fig. III.



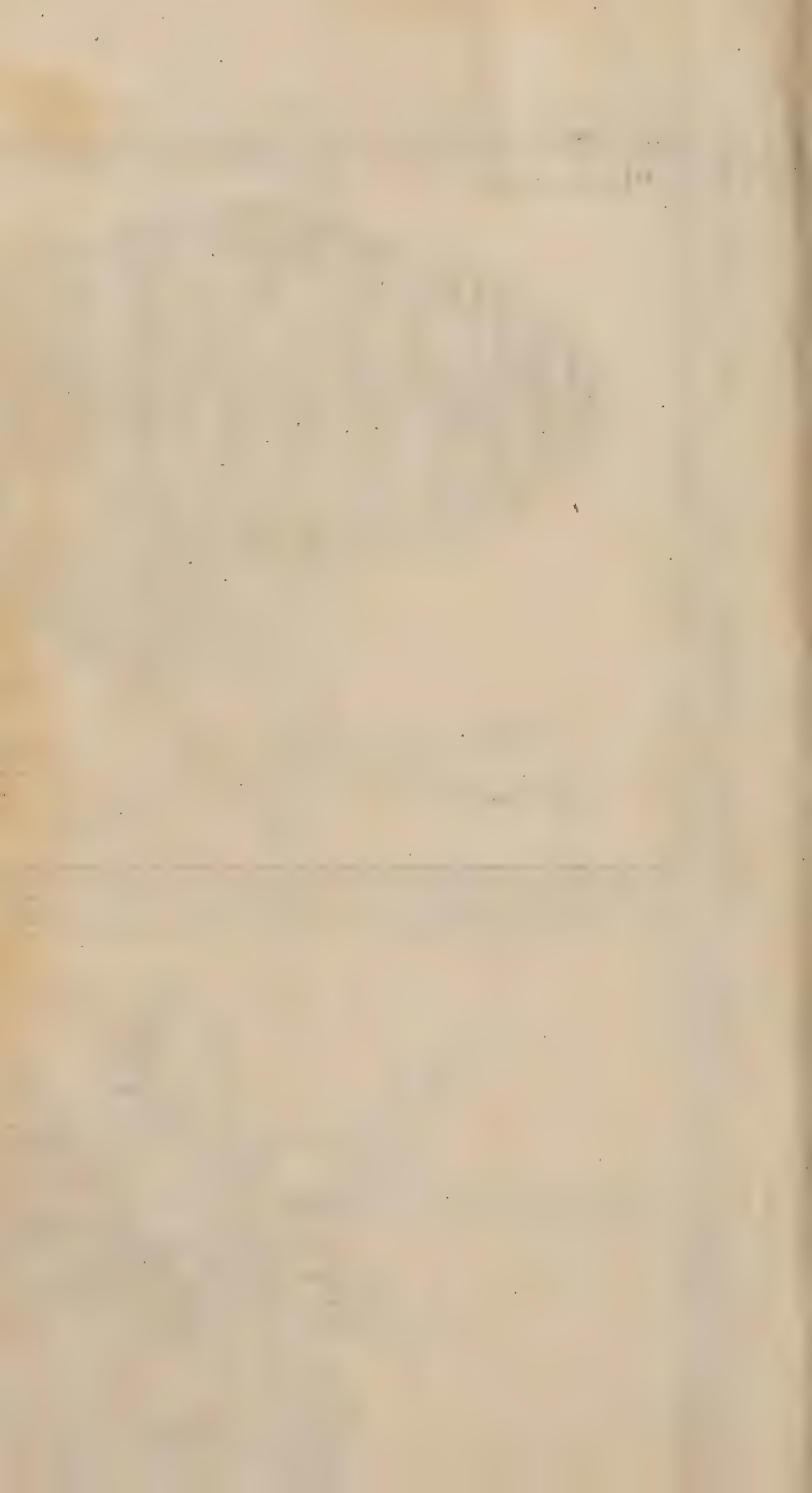




Plate XXIX.



*I. Basire sculp.*



Bus 192

70

of a Pigeon flying 124

Found in a stone 16







